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Employment Returns

IT was officially announced by the Ministry of Labour and National Service on Monday, August 5th, that between June 17th and July 15th there was an increase of 60,431 in the number of unemployed persons on the registers of employment exchanges in Great Britain. Owing to the increasing extent to which persons actually in employment or likely to be soon in employment are now admitted to training centres, it has been decided to discontinue the practice of including in the total of unemployed the number of unemployed persons at training centres. If they had so been included this month, the increase in the total would have been 68,225. The increase in unemployment since June 17th occurred mainly in coal-mining, where there were temporary stoppages in a few areas, and in the textile, clothing, boot and shoe, leather, and furniture industries. On the other hand there was a further reduction in the numbers unemployed in building and public works contracting and in the distributive trades. An analysis of the number of unemployed shows that the total of 827,226 on the registers at July 15th is made up of 336,292 men wholly unemployed and 76,958 temporarily stopped, these men being normally in regular employment. There were 35,716 unemployed men who normally are in casual employment. Similar figures for boys are 18,363 wholly unemployed, 2765 temporarily stopped and 103 in casual employment; for women the figures are 248,025, 69,293, and 1665; and for girls, 33,852, 4226, and 8.

Second-Hand Machine Tool Prices

AN Order which will ensure a check on all prices charged for second-hand machine tools has been signed by Mr. Herbert Morrison, the Minister of Supply, and came into force on Thursday, August 1st. The Order requires all second-hand machine tool dealers to register with the Ministry and to keep a register of their dealings in machine tools. On and after Saturday, August 17th, no dealings in second-hand machine tools will be authorised except under a licence granted by the Minister of Supply. A copy of the Control of Machine Tools (No. 3) Order, 1940, dated July 29th, 1940, can be obtained from the Stationery Office or through any bookseller. A form of application for a licence is set out in the schedule to the Order, and can be obtained from the Machine Tool Control, the Ministry of Supply, Adelphi, London, W.C.2. The Minister of Supply has power to revoke any licence. Every authorised dealer in second-hand machine tools is required under the Order to keep a register at his principal place of business, showing particulars of his purchases and sales, which register shall be available for inspection on behalf of the Minister of Supply at any time. It is also provided that an authorised dealer shall not offer for sale or dispose of any used machine tool to any other person other than to a Government Department, or to a person who requires it for use in his business and not for disposal. A definition of machine tools is set out in the Order and the Minister of Supply may from time to time make Directions fixing prices.

The "Alcantara's" Naval Engagement

ON Wednesday of last week, July 31st, it was officially announced by the Admiralty that the armed merchant cruiser H.M.S. "Alcantara" had attacked the German raider "Narvick" in the South Atlantic. The "Narvick" is reported as a ship of between 8000 and 9000 tons, having one short funnel, two vertical masts and short topmasts, and a sloping bow. She is mounted with four guns, of probably 5·9in. calibre on each broadside. When she was sighted by the "Alcantara" the ships were at some 16,000ft. range, which was closed to about 9000ft. by the "Alcantara" before the enemy managed to escape behind a smoke screen. She was last seen about 600 miles east of Rio de Janeiro. Although the raider was hit, she at once turned away, making use of smoke floats. She is known to have sustained damage affecting her fighting efficiency. The raider was chased by the "Alcantara," but a lucky shot on the water line which exploded in the engine-room, damaging four extraction pumps and the machinery in the generator room, so reduced the "Alcantara's" speed that she had to give up the chase. The damage sustained was comparatively slight, but two men were killed and seven wounded. Despite the damage, the liner was able to make about 10 knots speed, and she put into Rio de Janeiro on Thursday, August 1st, for repairs which were completed in time for her to put to sea again on Monday, August 5th. The "Alcantara" was formerly a 22,209-ton liner engaged in the South American trade of the Royal Mail Lines, Ltd. She was built and engined by Harland and Wolff, Ltd., at Belfast in 1926 as a motorship, and in 1935 was re-engined with twin-screw Parsons single-reduction geared turbine machinery, taking steam at a pressure of 385 lb. and a final temperature of 700 deg. Fah. from three Johnson oil-fired water-tube boilers. Her service speed of about 18¾ knots has been well maintained in company with her sister ship the "Asturias" in the Royal Mail service between Southampton and the South American ports.

The Grampian Power Scheme

A FURTHER stage in the completion of the power scheme for the Grampian Electricity Supply Company was reached last week, when the final blast was made connecting up the two ends of a 4½-mile tunnel between Loch Seilich and Loch Cuaich, some miles from Dalwhinnie, in connection with the scheme for the provision of additional water which is now being carried through by Balfour, Beatty and Co., Ltd., of London. The tunnel, by means of which the waters of Loch Seilich will discharge into Loch Cuaich, has a diameter of 9ft., and it passes underneath mountains reaching a maximum height of 1000ft. above it. The work has involved the drilling, blasting and removal of 100,000 tons of rock. Boring from each end of the tunnel, work has been going on for fully two years, and it is a tribute to the skill of the engineers that an examination after the final blast revealed that a perfect junction had been made. Near Loch Seilich a dam is being constructed across the River Tromie, in order to store and divert the water from the loch into the tunnel. This work also includes the building of a salmon ladder. The waters of the Allt Bhran stream are being diverted by a second tunnel about 1¼ miles long, bringing them into Loch Seilich. The levels at each end of the tunnel are such as to give a fall of 100ft. in the 4½ miles of tunnel. After the water emerges from the tunnel at Loch Cuaich it follows a natural stream for about a mile to an intake structure, diverting it into the Cuaich aqueduct, a concrete lined structure with a width of 30ft. and a depth of 6ft., which reaches Dalwhinnie at a point some 3 miles distant. It then enters a 7ft. 6in. concrete pipe which takes it across the River Truim and under the L.M.S. Railway to enter Loch Ericht nearly half a mile away. Some 350 to 480 men have been engaged on the work and they were housed in special camps. The successful completion of this tunnel marks one of the final stages in the construction of the Grampian power scheme, which, it may be recalled, was started in 1927 by building a dam across Loch Ericht and constructing a 3-mile tunnel with steel pipes to the Rannock power-house. The supply of electricity was begun on November 19th, 1930.

Lighting in Factories

THE fifth report of the Departmental Committee on the Lighting of Factories, which has met under the chairmanship of Sir Duncan R. Wilson, has now been issued by the Stationery Office. The fourth report, it may be recalled, was issued in September, 1938, and was summarised in our issue of December 2nd of that year. The new report submits amended recommendations, which take into account developments since the outbreak of war. The Committee recommends that over the interior parts of factories, in which persons are regularly employed, the illumination shall be not less than 6 foot-candles, without prejudice to any additional illumination required by the nature of the work. Provided that in parts of factories where persons are employed, in which the mounting height of the light sources necessarily exceeds 25ft. measured from the floor, or where the structure of the room prevents the uniform provision of the standard above mentioned, the illumination shall be not less than 2 foot-candles, and not less than 6 foot-candles, where actual work is being done, without prejudice to any additional illumination required by the nature of the work, the illumination being measured in the horizontal plane at a level of 3ft. from the floor. Over all interior parts over which persons employed are liable to pass, other than those in which persons are regularly employed, the illumination at floor level shall not be less than 0·5 foot-candle.

The Purchase Tax and Exports

THE Federation of British Industries announces that it welcomes the statement of Sir John Simon that the Purchase Tax would be so devised that goods intended for export would not be liable for the tax. The Purchase Tax Bill, now withdrawn, and the Finance (No. 2) Bill that has taken its place were so drafted as to endeavour to carry out this pledge. It is, however, possible, says the Federation, that it may be beyond the power of the British Parliament to ensure this so long as the tax is based upon the wholesale price of goods in the home market. Both the United States of America and several Dominions in their Customs legislation insist that the rate of duty payable on exports from the United Kingdom must be assessed upon the wholesale value of similar goods sold in the home market at the date of shipment. It therefore follows that, if the Purchase Tax is applied, not as a Retail Sales Tax, but at the stage when goods pass from wholesaler to retailer, the "home market price" of chargeable goods may be ruled to have been increased by 33⅓ per cent., or 16⅔ per cent., as the case may be, with consequential increases in the duty payable on goods of the same class on importation into the U.S.A. or the Dominions concerned. Such a ruling could not fail to have a seriously adverse effect on our export trade to these markets at a time when it is vitally necessary to do all in our power to increase exports in order to pay for the imports essential for war purposes. The Federation first raised this aspect of the tax with the Board of Trade and the Export Council three months ago and has since, in consultation with them, endeavoured to discover means whereby this danger can be removed. It has been forced to the conclusion that no solution can be found except by revising the incidence of the tax and by imposing it as a Retail Sales Tax. In view of the great national importance of our export trade, especially to the United States of America, at the present time, the Federation urgently asks for the machinery of the tax to be recast along these lines. Otherwise the effect of the tax, especially when combined with the inevitable increase of export prices of many goods arising from the Limitation of Supplies Order, might seriously worsen our exchange position.

Labour Problems in the Colonial Empire

LABOUR problems in the Colonial Empire were discussed in a second course of instruction for Administrative and Labour Officers recently given by the Colonial Office. In an opening address Mr. G. H. Hall, Parliamentary Under-Secretary of State for the Colonies, said that during the last few years the necessity for grappling with many pressing labour problems had been fully realised in the Colonial Office and by all Colonial Governments, and a large volume of labour legislation of every kind had been enacted. Three years ago there were only seven Colonial Dependencies which had either separate Labour Departments or had appointed full-time Labour Officers and Inspectors. To-day the number of such territories was twenty-seven, and the number of full-time Labour Commissioners, Advisers and Inspectors was more than three times the numbers in 1937. The Government was determined that no one should have grounds for saying, at the end of the war, that everything possible was not done to maintain vital social services. The Colonial Development and Welfare Bill made provision for the establishment or expansion of Labour Departments. The policy of the Colonal Office, with regard to the staffing of Colonial Labour Departments or Inspectorates, was to allow Colonial Governments wherever possible to select officers of their own administrations. In the case of the smaller Colonies which had no large administrative staffs, labour appointments had been filled either by seconding experienced officers from other Colonies or by the selection of recently retired officers of the Colonial Service or in certain special cases by seconding officers of the Ministry of Labour and National Service. The trade union movement, said Mr. Hall, had in the last few years developed with amazing speed in some of the Colonies. Three years ago there were practically no trade unions at all in most Colonial Dependencies, although the laws permitted of their being formed. To-day nearly 200 unions had been registered, the majority of which were in Ceylon, Mauritius, Cyprus and the West Indies, though several unions had already been registered in the West African Colonies and one or two in the East African Dependencies.

The Harbour of Hong Kong

ON Thursday, August 1st, it was officially announced by the Dominions and Colonial Offices that Sir David Owen, who retired from the General Managership of the Port of London Authority in 1938, had accepted an invitation from the Government of Hong Kong to visit the Colony for the purpose of advising upon the future administration of the port. He will be accompanied by Mr. Duncan Kennedy, M. Inst. C.E., who will act as engineering adviser. Sir David expects to leave for the Far East next month. The terms of reference of his inquiry will be to investigate the whole question of harbour facilities, organisation and administration at Hong Kong, having regard to the existing system of pier leases, which are due to expire in ten years' time; and in the light of physical, economic and political conditions to make recommendations for measures by which the port could in future be developed and controlled to the best advantage of all persons and interests dependent upon its services. During his sixteen years of service from 1922 to 1938 at the Port of London Sir Owen inspired and assisted to carry out, in collaboration with Mr. Asa Binns, M. Inst. C.E., now President of the Institution of Mechanical Engineers, many important schemes of improvement and development.

Automatic Train Control

No. V

(*Continued from page 70, August 2nd*)

IN America, as in this country, it has been found necessary to install lineside signals displaying as many as four different indications. The severe demands of modern traffic, wherein a particular stretch of line may be used by ultra-high-speed streamlined trains, a succession of heavy passenger and an intense service of multiple-unit electric trains render a system of three-indication signalling somewhat inflexible under the very conditions where signalling should be of the greatest assistance in increasing the capacity of the line. Various codes have been devised in America in four-indication signalling and the application of automatic train control on stretches of line so equipped has developed in a striking way.

The three-speed train control system described in the fourth article of this series has as its basis the two-element control relay that is capable of taking up any one of three positions; these correspond to high, medium and low speed. There is no means of making a relay of this type assume more than three positions, and when the need arose for a train control and cab signalling system based on four-indication lineside signals other means had to be sought of transmitting the necessary power to the locomotive equipment. The problem was complicated by the need for a system that would be applicable equally to electrified roads, using A.C. or D.C. propulsion, and also to steam-operated routes. An ingenious solution has been obtained by the use of what are termed "coded" track circuits. The alternating current fed into the track rails for ordinary signalling purposes is interrupted a certain definite number of times per minute; the frequency of interruption can be varied and this principle is used to transmit the appropriate currents required for cab signalling and train control.

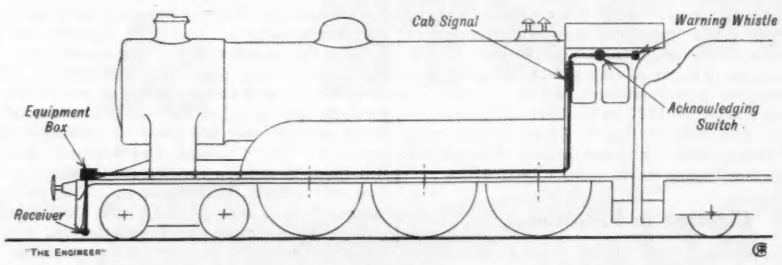


FIG. 32—EQUIPMENT FOR CODED CONTINUOUS CAB SIGNALLING

It will be appreciated that this method of transmission is at once a good deal simpler than the three-speed train control system first used in the U.S.A., and described in the fourth article of this series. No extra current has to be superimposed in the rails, over and above the current used for track circuiting; and since there is only one "signal" to be picked up a single receiver on the locomotive is enough. Fig. 32 illustrates the lay-out of the locomotive equipment, and Fig. 33 shows the receiver. Normally current flows continuously in the track circuits; the ordinary track relay is installed at the entering end, so that during the passage of a train through the particular block section track circuit current is passing through the leading wheels and axle of the locomotive. It is only when a locomotive or electric motor coach enters upon a track circuit and the track relay is thus de-energised that coding of the current begins; this is done by a device called the code transmitter, which consists of a series of contacts caused to make and break at various frequencies by cam action. Sufficiently accurate timing is obtained by the use of a synchronous motor for driving the camshaft. The particular contact over which the track circuit feed current is taken is selected according to the state of the line ahead. Typical frequencies of interruption used are 180, 120 and 80 per minute.

The currents induced in the locomotive receiver are, naturally, coded also, and so the first process to be carried out by the locomotive equipment, after amplification, of course, is to decode the received current; in proceeding to the decoding unit the current is passed through an electrical filter which suppresses all frequencies except that of the normal A.C. supply to the track circuit, thus preventing any interference from stray currents that may be present in certain localities. The decoding is accomplished by a series of condensers and reactance coils, each set of which is tuned to one of the frequencies of interruption that may be applied to the track circuit current. Thus if the track circuit current picked up by the locomotive receiver is being interrupted, say, 120 times per minute, the tuning of the decoding unit is such that only the circuits corresponding to that frequency of interruption are energised. In order to provide against the contingency of a failure of the code transmitting apparatus, the decoding unit is so designed that any uncoded current picked up by the locomotive receiver causes the "caution-slow speed" indication to be displayed in the cab. The equipment box is comparatively small and is often carried on the buffer beam, as shown in Fig. 34.

Such is the underlying principle of this latest form of American automatic train control. It has been applied in a considerable variety of ways. It has superseded the older form, not only where four indications are given, but also for three, and even two indication systems. The automatic stop and speed control features are not always included; in fact, the present trend seems to be to omit them and to rely entirely upon the cab signal continuously in front of the driver. The Canadian National, the New York, New Haven and Hartford, and the Central Railroad of New Jersey have each installed four-indication colour-light cab signals, with continuous automatic train control having three speed limits; while the Reading, also using four-indication cab signals, has only one speed control, enforcing the low speed limit. As mentioned in the third article of this series, the French National Railways have installed four-indication cab signals, without train control on the former Etat main line between Caen and Cherbourg. These interesting and important installations, together with many others that could be quoted, are not very large so far as American statistics go, and it is the experience and present practice of the Pennsylvania Railroad that provides the most valuable matter for discussion on the subject of continuous train control.

Prior to the invention of the coded system the Pennsylvania had gained valuable experience through installations of the earlier forms of automatic train control. Soon after the Inter-State Commerce Commission issued its first order, in 1922, an example of the three-speed continuous A.T.C. was put into service on the Lewistown branch; only 45 miles in length and involving the equipment of only thirteen locomotives, this installation was to a large extent experimental. The wayside signal is of a somewhat unusual type, to British eyes at any rate. These so-called position light signals have now been standardised on the Pennsylvania, and since their aspects are repeated in the cab signals an explanation of the various signs displayed is given in Fig. 35. Their equivalents in the British standard four-indication colour-light system are also included.

It will be seen that the first three of these indications correspond to the British "green," "double yellow" and "yellow"; the fourth, however, has a counterpart only on non-passenger lines in this country. This is termed "caution—slow speed," and allows a train to enter a block section that is already occupied, without stopping first at the wayside signal marking the entrance to such a block. Such working applies, of course, to automatic signalling and is calculated to keep trains on the move during heavy occupation of the line. It is certainly more flexible than the arrangement formerly used in this country, wherein a train arriving at an automatic signal displaying the danger indication was compelled to stop for a specified time before proceeding, with appropriate caution, into an occupied block section. It is more flexible still than the present British system, in which a driver must get into telephonic communication with the nearest control point in order to obtain authority to proceed in such circumstances. With the aid of continuous cab signalling the system in use on the Pennsylvania has given entirely satisfactory results.

In approaching a block section that is occupied a wayside signal displaying the "approach restricting" indication is first sighted. As the locomotive passes this signal the cab indication changes to correspond, and a warning whistle blows; this whistle continues to sound until the driver duly acknowledges the change in the cab signal indication by operating the acknowledging lever. The speed of the train is then suitably reduced, if the driver has not already done so on first sighting the restriction aspect displayed by the signal; a further reduction in speed must be made at the next signal, which, if conditions ahead have not altered, will be displaying the "approach" aspect. If, in the meantime, the road ahead has cleared, the driver will be immediately advised by the changing of his cab signal indication to a less restrictive aspect; in such a change there is no audible signal to accompany it, in contrast to the instance of a change of the opposite kind, when the whistle comes as a reminder of the need for taking instant action.

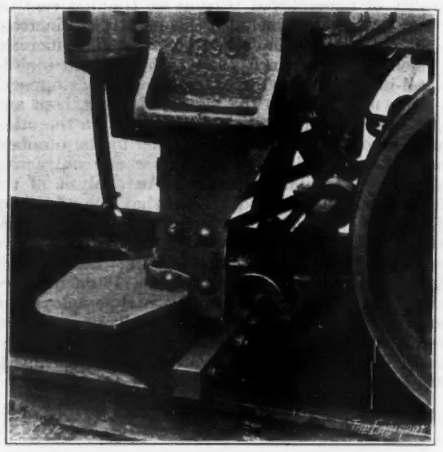


FIG. 33—RECEIVER ON LOCOMOTIVE

In American railway operating there are many locations where the speed of fast trains has to be moderated owing to curves. With continuous automatic train control the speed of the train can be accurately regulated and it might, on first thoughts, be imagined that such locations could be similarly protected by the display of one of the more restrictive signal indications, both at the lineside and in the cab. Many instances are to be found in this country, for example, of the use of distant signals fixed permanently in the caution position which, in conjunction with one or other of the forms of intermittent A.T.C., would cause an automatic brake application if the driver did not acknowledge correctly. There are, however, decided objections to such a practice, when applied to a main line carrying a heavy and frequent traffic, where it is most desirable to give drivers

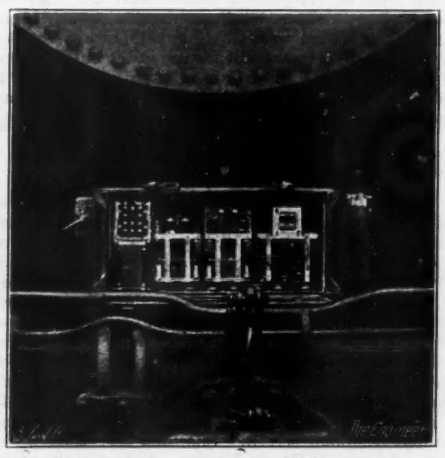


FIG. 34—EQUIPMENT BOX

the fullest possible information about the state of the line ahead. A particularly interesting example of this kind is to be seen on the Pennsylvania Railroad, on the difficult section between Altoona and Pittsburg, where the line crosses the Allegheny Mountains. On the steep descending gradient from the Gallitzin summit eastbound trains have to negotiate the famous Horseshoe Curve; speed would ordinarily rule high at this point, but owing to the alignment a limit of 35 m.p.h. is imposed. The section is equipped with this railway's standard system of four-indication continuous cab signalling, and the aspects displayed depend entirely upon the occupancy or otherwise of the block sections ahead. To remind the driver of the speed limit a special indicator is illuminated when passing over the affected length of track, and this speed limit is displayed irrespective of the ordinary cab signal. This special indication is given by interrupting the code normally given, so that instead of receiving the 120 interruptions per minute, for example, one interruption in, say, every five will be omitted; this provides the necessary special code for giving both the normal cab signal and the speed limit.

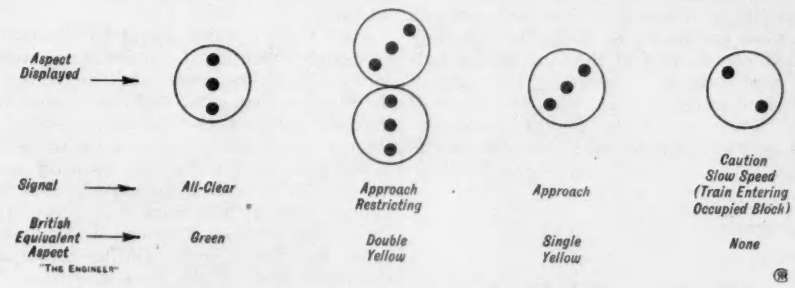


FIG. 35—CAB SIGNAL ASPECTS, PENNSYLVANIA RAILROAD

The extent to which the Pennsylvania Railroad and its associated companies is now relying on continuous cab signals, operated on the coded system, may be judged from the following remarkable statistics, representing conditions on January 1st, 1939. The total route mileage of the company is 10,377, and against this 6651 track miles are equipped with automatic block signalling; the total route mileage so equipped would probably be something less than half the above figure, as the bulk of it relates to double track and some to quadruple. But the most extraordinary point is that very nearly half the track mileage equipped with automatic block signalling, 3249 miles in all, is also equipped with continuous cab signalling on the coded system, all of it without train control. This includes the whole of the electrically operated main line from New York to Washington, and an immense stretch of the New York and St. Louis main line, from New York to Indianapolis, 801·6 route miles; as far west as Pittsburg this route is also used by the Chicago expresses, and it includes the mountain section previously mentioned.

Between Pittsburg and Harrisburg the density of the night express traffic is such that there are twelve heavy sleeping car trains within the space of 2½ hours, with one intense period having five trains in less than forty minutes. In working this succession over the 2192ft. altitude of the Gallitzin summit, with its average gradient, eastbound, of 1 in 130 for 26 miles, continuous cab signalling has proved of inestimable value; not less, however, than in the operation of the heavy goods traffic that passes at other times. The Pennsylvania Railroad have indeed gained such confidence in the cab signal, with its indication constantly in front of the driver, as to embark upon a further installation where no wayside signals are used at all. This at first sight seems so startling a development as to border upon rashness, and the mind conjures up visions of the possible confusion that might occur in the event of a failure of the cab signalling system. But the circumstances would be no worse than a failure on a long stretch of automatic block signalling such as is to be found in many sparsely populated parts of the U.S.A., and, of course, on the London tube railways, where, to take one example, the signalling is entirely automatic between Finsbury Park and Hammersmith during rush hours.

The use of cab signalling, without wayside signals, is not, however, new in America. Some years ago the Atchison, Topeka and Santa Fe Railway installed three-indication cab signals, with continuous A.T.C., throughout its main line from Chicago to Fort Madison; the difference in the Pennsylvania case is that no train control is included. The working of the Santa Fe installation, in the handling of a heavy traffic, has many features of particular interest. Goods trains are mainly concerned, the flow of cattle and package freight trains being towards Chicago in the morning and outbound in the evening. The headway between successive trains is at times so short that both roads of this double-track main line are arranged to be used in either direction, to meet traffic requirements. Thus, in the morning ingoing freight trains can run abreast of each other, although there are only two running lines.

To ensure the safe handling of trains in such conditions a fairly elaborate system of wayside signals would have been necessary, and it was partly on account of this that the decision was taken to eliminate wayside signals altogether and to rely entirely upon the automatic train control with its associated speed indications in the cab. Speed is limited to a maximum of 65 m.p.h., and for this the block sections were fixed at a length of 2600 yards. As in ordinary three-indication signalling, a driver has a complete block section—after receiving the caution indication—in which to bring his train to a stop, but on the Santa Fe an intermediate indication is given too. A train is allowed to travel at the full 65 m.p.h. up to 2600 yards from the entrace to an occupied block section, then the cab signal indication changes from "H" to "M" and speed is reduced to 40 m.p.h. Halfway through the warning section the cab signal again changes to "L" and speed is further reduced to 20 m.p.h.

The abolishing of the wayside signals has naturally given rise to a great deal of discussion, particularly as to the probable psychological effect on enginemen, but on the railway in question it has proved successful, and from all accounts is much appreciated by the drivers as a real aid to better timekeeping. Moreover, in first cost it actually proved cheaper than the wayside signalling arrangement that would have been required to provide the same traffic facilities. A further interesting point brought out first in connection with this Santa Fe installation is the difficulty of co-ordinating the indications displayed by the wayside signals with the appropriate automatic train controls and corresponding cab signals. In a system such as that now used on the Pennsylvania there are, inevitably, times when the wayside and cab signals disagree; this occurs when a train is travelling at speed, with the cab signal showing the "all clear" and a wayside signal ahead is sighted displaying the "approach-restricting" aspect. There is no need for the driver to take action until the wayside signal is actually passed, and it is not until then that the signal in the cab changes. In many ways the sight of an adverse signal some distance ahead is a definite advantage, as it warns a driver of the impending change in the cab signal indication; but with the latter showing continuously and with a hooter as well to draw the driver's attention there is—so it is argued in certain quarters—no need for the wayside signal at all, especially if automatic control of the brakes is provided too. The forthcoming installation on the Pennsylvania of continuous cab signalling with neither wayside signals nor train control carries the matter yet another stage farther, and its completion will be awaited with unusual interest.

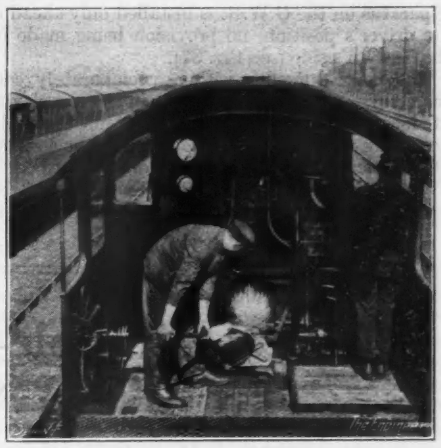


FIG. 37—CAB OF G.W.R. LOCOMOTIVE

In bringing this series of articles to a conclusion and recalling once again the position in Germany, the present trend in France, and these latest American developments, one cannot help attempting to take a look into the future of our own railways so far as A.T.C. is concerned. In the face of the definite swing towards cab signalling alone, it has always been argued in this country that the installation of miniature colour-light or other visual signals in the engine cab would distract a driver's attention from the road ahead. It must, however, be admitted that very little can be seen at night, and the provision of a continuously controlled signal in the cab would appear to go a long way towards relieving the undoubted strain of fast night running, with its continuous peering

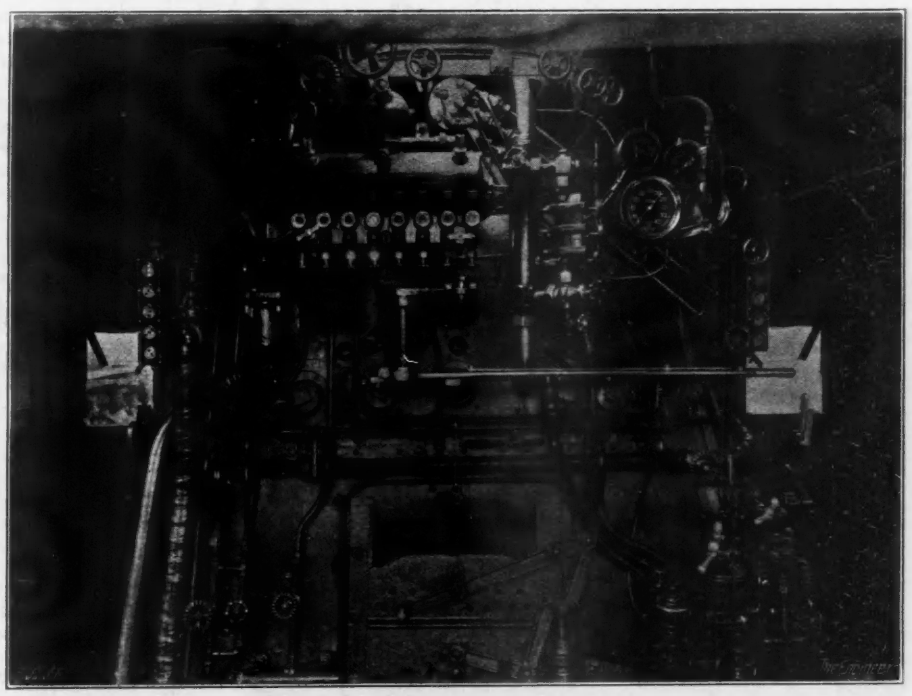


FIG. 36—CAB OF PENNSYLVANIA LOCOMOTIVE

into, maybe, murky darkness to sight the wayside signal lights. In this country all main and branch lines are properly fenced, and drivers have not to maintain their schedules on routes intersected by unprotected level crossings and passing at times through the main thoroughfares of country towns. American enginemen do not appear to find the cab signals distracting, judging by the confidence with which they run through localities such as just described, making, it must, however, be added, the fullest possible use of the whistle. As shown in Fig. 35, the cab signals in the Pennsylvania are installed on both sides of the cab, for both driver and fireman, whereas the audible cab signalling apparatus on the G.W.R. is installed only ahead of the driver's position, no provision being made on the fireman's side (see Fig. 37).

The main difficulty with any elaborately conceived system in this country lies in the complexity of locomotive workings, consequent upon the arranging of long daily mileages within the confines of this island. It might be very desirable to equip a certain critical section of main line for reversible working, as on the Santa Fe, and in order to increase line capacity to the very maximum to install continuous cab signals; but for any such scheme to be wholly successful every locomotive passing through that section should be equipped. In the light of the operational advantages to be gained the cost, in most British localities, would on this account be altogether prohibitive. Yet long before the present emergency there was increasing evidence that many stretches of line, even under the depleted traffic conditions that led to the "Square Deal" campaign, were being worked almost to their maximum capacity. In the complete rationalisation of the nation's transport on a peace footing, that it is to be hoped will be undertaken after the war, the question of line capacity in relation to existing facilities will have to be considered in many districts if adequately fast and efficient service is to be provided. So far as cab signalling is concerned, one at least of the four British railways has gone so far as to install a trial length of coded track circuits, though whether this will eventually prove to be the forerunner of cab signalling as used in France and America remains to be seen.

Bartlett Multiple-Arch Dam, U.S.A.

No. II

(*Continued from page 72, August 2nd*)

THE main part of the Bartlett dam consists of ten inclined arches of 48ft. clear span on the intrados, alternating with nine hollow walls or buttresses which are spaced 60ft. between centres, measured on the line of the axis of the dam. This main part is supplemented by a short, solid abutment of gravity section built into the hillside at each end. The total length is thus 800ft. The axis of the dam is on a curve of 1380ft. radius, and the centre lines of the buttresses are radial to this curve, diverging at angles of 2 deg. 30 min. All the arches are semi-circular. For the intrados of the arch barrels and the upstream ends of the buttresses, the slope is 0·9 to 1, while the downstream ends of the buttresses have a slope of 0·36 to 1. The extrados of each arch is conical, owing to the varying thickness of concrete in the barrel. This thickness of the arches and the upstream ends of the hollow buttresses ranges from 7ft. at the base or toe, Elev. 1540, to 2ft. 4in. at the crest, Elev. 1795·5.

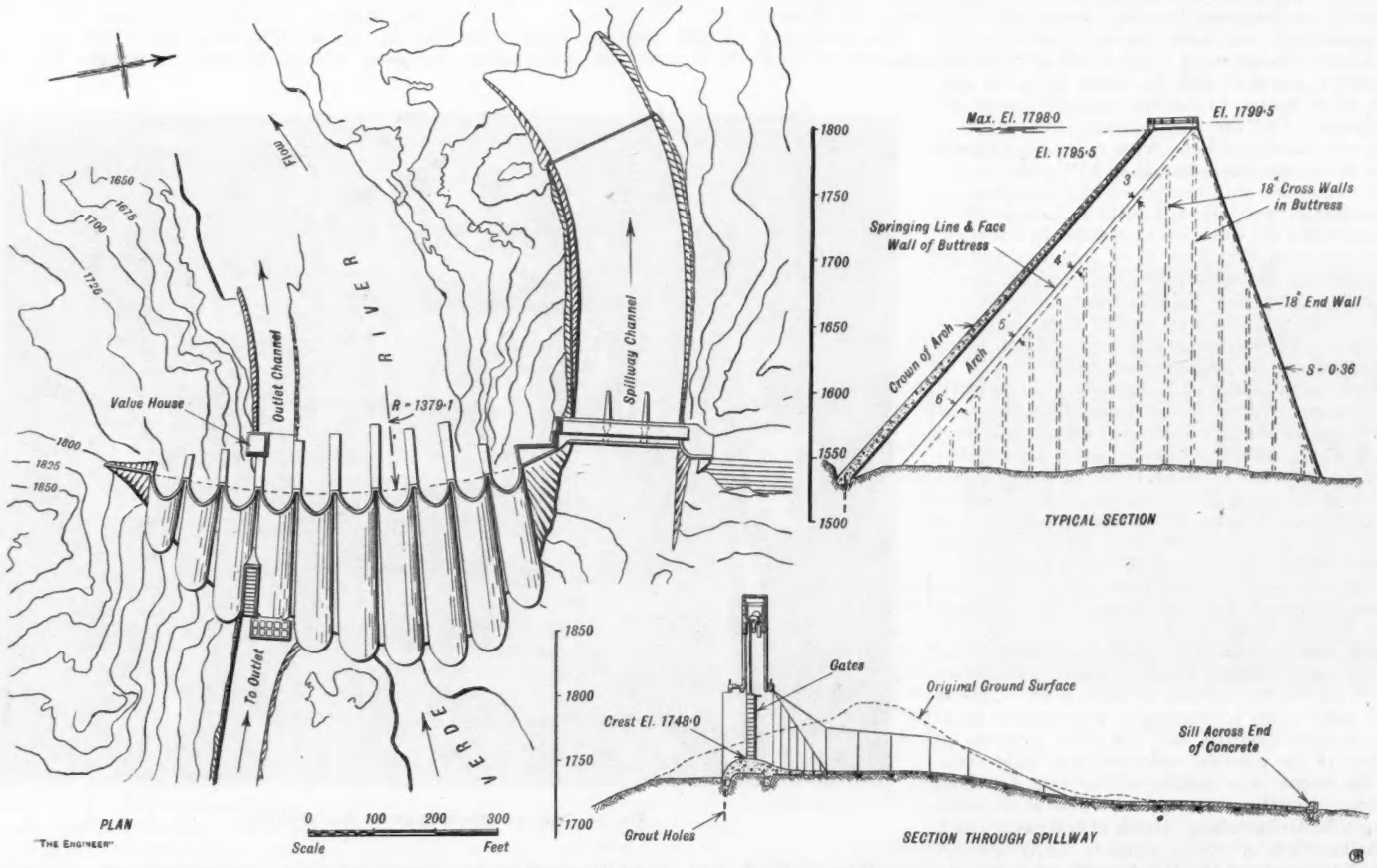
A plan of the general lay-out of the dam and its appurtenances is shown below, together with its typical construction and its auxiliary works for control of use of the stored water and control of flood waters. In the hollow buttresses the outer faces of the walls have a vertical batter, while the inner faces are vertical, thus tapering the thickness. Beyond the springing line of the arch the thickness of the buttress walls reduces in a downstream direction from 4ft. 6in. to 2ft. at the end. With the vertical inner faces of the side walls the hollow space has a uniform width of 8ft., and the walls are reinforced by vertical and diagonal transverse walls or stiffening diaphragms 18in. thick. The upstream end of the buttress is closed by a slab 7ft. to 2ft. 4in. thick, while a 2ft. slab closes the lower or downstream end. Openings in the walls and the interior diaphragms provide for ventilation of the enclosed space and tend to equalise the temperature.

Vertical contraction joints in saw-tooth arrangement, with 5ft. steps, are spaced 41ft. 6in. apart along the buttresses. These joints were filled after the heat due to the setting of the concrete had been dissipated.

In the preliminary part of the construction work, for the foundation work and the lower part of the dam, there was first the stripping of the overburden on the hillsides, and also rough excavation for the buttress footings and the spillway channel. To expose a part of the river bed and permit construction to begin on some of the buttresses on the left side, a cofferdam was built in the middle of the river, with connections to the left bank, in order to concentrate the river flow to the right side. However, the foundations required deeper excavation than had been expected, and this, with heavy seepage through the river gravel, delayed the early part of the work considerably.

After further delay caused by the 1937 floods, previously mentioned, cofferdams were built across the river, above and below the site of the dam, so that work could be carried on across the full width of the channel. During part of this early work the normal flow was carried through a 6ft. pipe culvert designed to carry a summer flow of 200 cubic feet per second. But with this limited capacity the work was again submerged for a short time by a sudden flashy flood of 375 cubic feet per second. During construction on the upper part of the dam, the river flow was diverted through a channel between two of the buttresses, the arch being omitted temporarily. In spite of early unfavourable conditions the work was carried out practically according to the original schedule, certain changes in the specifications being made to permit of expediting the construction operations. The construction view on page 87 shows three of the barrel arches and three buttresses, with a gravity abutment at the right. For a structure of this type a high quality of concrete is indispensable. The amount required was about 85,500 cubic yards in the buttresses and 35,000 in the arches, or a total of 120,500 cubic yards, which was placed at an average rate of 12,000 cubic yards per month, while daily work ranged from 400 to 1000 cubic yards. At the concrete-mixing plant graded aggregate materials were delivered by motor trucks to timber bins or bunkers from which there was gravity feed to automatic measuring and weighing apparatus. Belt conveyors then delivered the sand and varying sizes of gravel to the mixer, of 2 cubic yards capacity. Cement was added last, before turning on the water. The gravel aggregate was graded into three sizes—$\frac{3}{16}$in. to $\frac{3}{4}$in., $\frac{3}{4}$in. to $1\frac{1}{2}$in., and $1\frac{1}{2}$in. to 3in.

A special low-heat Portland cement was used, as concrete made with this cement develops a



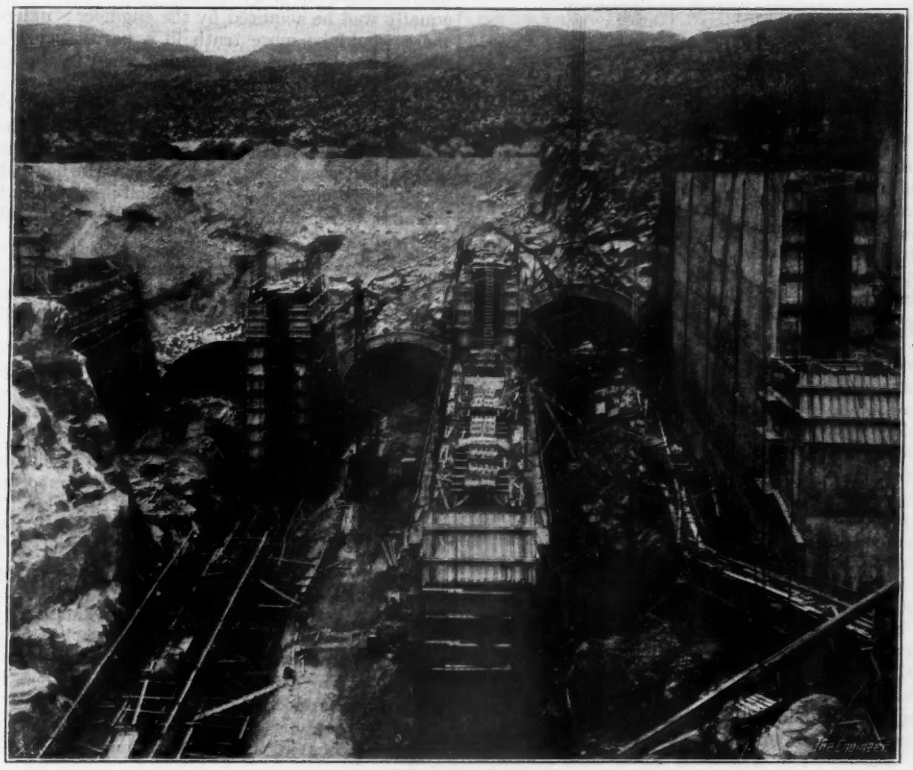
PLAN AND SECTIONS OF BARTLETT DAM

setting heat quite slowly, and cracking is thus eliminated. But the concrete develops strength more slowly than that made with a standard cement, becoming equal to the latter in the course of a few months. When a modified standard cement was used in the early part of the work, hair-line cracks appeared in the buttresses, but this trouble disappeared with the introduction of the low-heat cement. With a small, but well-equipped, laboratory at the mixing plant, sieve analyses of the aggregates were made at two-hour intervals and also tests of moisture content, while slump tests were made for each 100 cubic yards of concrete. The slump specified was from 3in. to 4½in., depending upon the proportions of the mixture. Control specimens or samples of the concrete showed a compressive strength rising from 1450 lb. per square inch at seven days to 3440 lb. at ten days, 6100 lb. at six months, and 7030 lb. after four years.

A large proportion of the concrete was placed by pumping it from the mixing plant. However, concrete for the deep footings was handled by drop-bottom buckets which were carried on motor trucks and delivered to the forms by travelling jib cranes. The mixing plant, with a mixer of 2 cubic yards capacity, was installed about 300ft. downstream from the dam. At first, the pump was at approximately ground level, or Elev. 1640, and the mixer drum discharged the concrete into a hopper from which the concrete was fed to the pump by gravity. The 8in. pipe line was carried on timber trestling, with a light suspension bridge for crossing the river channel. The pipe did not discharge directly into the forms, but into a bin or hopper, from which the concrete was loaded into wheeled carts or buggies for distribution to the forms. With this arrangement the maximum vertical lift was 45ft., in a pipe line having several bends, and the maximum length of pipe was 785ft.

When the concreting had advanced to such a height as to require a higher lift, the pump was removed and installed at about Elev. 1780. Here the concrete was delivered to it by 2-yard buckets carried on an inclined cableway or ropeway. For distribution a steel truss bridge was built at such an elevation above the crest level of the dam as to allow of placing concrete for a 40ft. lift of the dam, after which it was raised for placing a second 40ft. lift. The truss spans were supported by steel towers 6ft. square in section, the legs or columns being seated on shelf angles anchored to the side walls of the buttresses. In each tower was a hopper of 2 cubic yards capacity, which was filled from the overhead pipe by means of a telescopic pipe or chute, and from which the concrete was discharged into the wheeled handcarts or buggies which delivered it to the forms.

The duplex piston pump for the concrete had two cylinders 8in. in diameter, discharging alternately into the 8in. pipe through a forked or Y connection. It delivered 50 cubic yards per hour under favourable conditions. Concrete was handled in this way for distances of 200ft.



CONSTRUCTION OF ARCHES AND BUTTRESSES

to 1000ft. and to levels ranging from 80ft. below to 100ft. above the pump. To prevent heating and drying of the concrete during its travel in very hot weather, the pipe was wrapped with two layers of burlap, which were kept wet by a sprinkling system. In this way, when the atmospheric temperature was above 100 deg. Fah., the concrete as delivered at the forms was cooler than when discharged from the mixer.

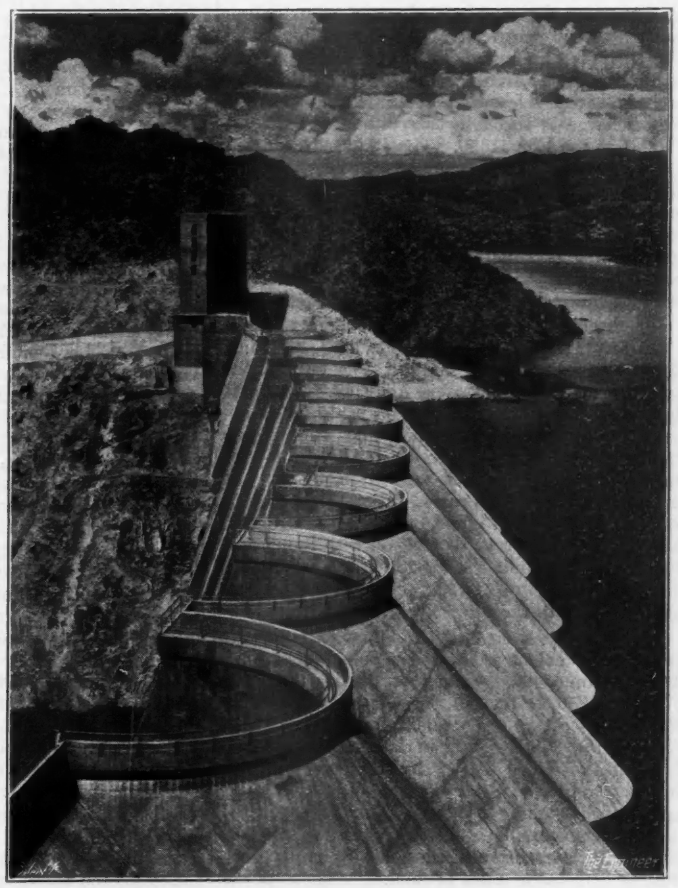
For the top of the dam and adjacent parts, drop-bottom buckets of 2 cubic yards capacity were used, and were handled by a cableway or ropeway of 1140ft. span between its supporting towers. As the cableway was fixed and had no lateral travel, the cable itself was shifted laterally as required by lines from two parallel cables, 200ft. upstream and downstream from the main cable. These drift lines were operated by separate hoists or winches, but at first they were handled by attachment to tractors.

Density and thorough compacting of the concrete in the forms, as well as its close bonding with the reinforcing steel, was assured by the use of electric and pneumatic vibrators. These were of the "internal" type, in which the vibrating element is embedded in the freshly placed concrete. Construction joints in the arches and foundation footings were cleaned by sand blasting with wet sand. Other construction joints were cleaned by high-pressure jets of air and water, and were then covered with an inch or so of sand.

To insure relatively rapid procedure in concreting, when work got into full swing after the delays by flooding, a system of temperature control of the concrete was devised, based on cooling by evaporation. But temperature control was not an easy matter in the hot summer climate of Arizona. However, it was helped by the relatively low humidity and the resulting wide difference between dry and wet bulb temperatures. Thus, with air temperatures at or above 110 deg. Fah., the wet bulb temperatures are 68 deg. to 74 deg. This condition is favourable to the principle of cooling by evaporation, and the problem of cooling the concrete was solved by the installation of a fog-spray system. All freshly placed concrete was sprayed from fog-spray nozzles on perforated pipes placed about 30in. from the surface of the concrete. In this distance the temperature of the spray water was reduced approximately from 90 deg. to 72 deg. Fah., and this latter temperature was maintained in the thin film of water that flows over the surface of the concrete. The temperature of the concrete as pumped to the dam was kept below 88 deg. Fah. by spraying the stock piles of aggregate, by using spray-cooled water for mixing, and by wrapping the delivery pipe with burlap which was sprayed continuously, as before mentioned.

It had been specified originally that alternate arches must be built first, and the intermediate arches only during the comparatively cool period of October to May. But with the low-heat cement and the fog-spray cooling system, the setting heat of the concrete was dissipated in less time than had been anticipated, and the temperature was so reduced in twelve to eighteen days—depending upon the thickness of the concrete—that it was practicable to build adjacent arches simultaneously. In the same way the contraction joints in the walls of the buttresses could be filled in about two weeks, instead of waiting for ninety days, as originally planned. Curing of the concrete was by water, applied generally through 1¼in. perforated pipes, and supplemented by the use of hand hose. But during the summer of 1938, to expedite some parts of the work, the water was applied through fog-spray nozzles in the manner already described.

Steel reinforcement is used throughout, except in the footings and the short gravity abutments. Circumferential and longitudinal bars are provided in both faces of the arches. The longitudinal bars are 12in. apart where adjacent to the buttresses and 24in. apart elsewhere. They are spliced to dowels or anchor bars embedded in the footings. Circumferential bars of about 8in. spacing were spliced to bars in the walls of the buttresses, thus



VIEW ALONG TOP OF DAM

avoiding splices at the springing lines. Reinforcing of the buttress walls consisted of diagonal and vertical bars, at the outer faces only, to take up temperature stresses, while the upstream end walls were reinforced for weight of water, or water load.

Forms for the concrete were of steel on the greater part of the work, but wood forms lined with plywood sheets served for footings and for the gravity sections at the ends of the dam. For the semi-circular intrados of the arch barrels, the forms were faced with ¼in. steel plates curved to the radius of 24ft., these being backed by rolled joists and by trusses in planes at right angles to the sloping face of the arch. For the forms of the extrados, similar facing plates were backed by rolled steel joists curved to an average radius. Detachable narrow plates along each side were removed as the forms rose, to allow of adjusting or shortening the radius as the thickness of the concrete decreased. Form work for the hollow buttresses was complicated by the tapering thickness of the side walls, both vertically and longitudinally, and also by the interior cross walls and the saw-tooth contraction joints.

The arch forms were made for 15ft. lifts or lengths of concreting, equivalent to about 10ft. vertical rise. They weighed 36 tons for the intrados and 26 tons for the extrados. These intrados forms travelled on rails fastened to the inclined side walls of the buttresses, and were raised by means of three hand winches, with cables attached to the middle and ends of the form framing. The extrados forms were supported on rails attached to the inclined end walls of the buttresses. Forms for the buttresses were in 40ft. panels for the outside of the walls and 20ft. panels for the inside of the walls. They were handled by the cableway or ropeway of 1140ft. span, already mentioned.

Every effort was made to ensure a solid, dense, and waterproof structure. An inspection in the autumn of 1939 showed dry foundations. Five of the arches were entirely free from leakage or wet spots; the others showed some small damp spots at construction joints, and along the springing lines, but it was expected that these would be self-sealed within a few weeks. A 3in. drainage hole in the gravity abutment on the left side discharged a maximum of 3 gallons per minute, and three others dripped slightly. All the others were dry.

Outlet and Regulating Works.—Outlet works for regulating the discharge of water for irrigation include three electrically operated slide gates, 6ft. by 7½ft., mounted in a concrete chamber within one of the arches, and used when the head in the reservoir is less than 100ft. At higher heads the discharge is through two 6ft. steel pipes at Elev. 1635 and Elev. 1650. These pipes are located in the buttress next to the arch having the slide gate openings, and each pipe is fitted with a 66in. needle valve. The lower needle valve is 23ft. above the top of the slide gate openings, and the upper valve is 15ft. higher. Water discharged from the valves and slide gates is carried off by a concrete channel to the old river channel.

For discharge of excess flood waters there is a spillway 170ft. wide and 650ft. long, of which 550ft. has a concrete lining. The sill at the entrance of the spillway is at Elev. 1748. As the channel is curved the bottom is sloped transversely to give a super-elevation that will equalise the flow throughout its width. At the end of the concrete is a cut-off wall in a trench cut in the rock, and also a raised lip or sill to form a pool or bucket. The effect of this lip is to cause the water to leap clear of the concrete lining and thus prevent or limit the erosion of the weathered and comparatively soft rock of the channel which leads the flow to the river bed.

With the reservoir full, the flow through the spillway is calculated at 175,000 cusecs, but at maximum flood stage of the river, with a flow of 250,000 cusecs, the spillway will carry 225,000 cusecs, and the remaining 25,000 cusecs will overflow the crest of the dam. Flow through the spillway is regulated by three vertical-lift Stoney counterbalanced steel gates, each 50ft. square and weighing 200 tons. They are operated at a travel of 4in. per minute by electric motors of 7½ H.P., current being supplied by two petrol-engined generator units of 35 kW. These power units also supply current for lighting and for the operation of the slide gates of the outlet system.

Design, construction, and future operation of the Bartlett dam and its control works are under the direction of Mr. John C. Page, Commissioner of Reclamation, with Mr. R. F. Walter as Chief Engineer of the U.S. Bureau of Reclamation, and Mr. J. L. Savage, Designing Engineer. The dam was built under contract by Messrs. Barrett and Hipp, and the Macco Company, and its cost approximated £1,000,000. Construction work was commenced in August, 1936, and was completed in June, 1939.

The Parrot Cry

(Contributed)

The country is becoming increasingly alive to the damage that may be wrought to the national cause by both listening to and repeating rumours. There is another failing, somewhat analogous, to which many of us are prone, that of adopting as our own a slogan we have heard, and repeating it later with the utmost conviction, without having first weighed its value. When the Apostle Paul was endeavouring to convert the men of Ephesus, the advocates of the goddess Diana took up the challenge, claiming that she had descended from heaven. A cry once raised was readily accepted, and it is recorded, "all with one voice about the space of two hours cried out, Great is Diana of the Ephesians." Now it is highly probable that many of the citizens had no real respect for the meteoric stone, which had been superstitiously preserved, but it is equally probable that after the expiry of those two hours many actually believed that their goddess was worthy of veneration. We may laugh at them, but are we not similarly guilty?

How often have we heard engineers and administrators aver that "there is no sentiment in industry," albeit a most untruthful statement, seeing that there must be genuine sympathy and sentiment if industry is to operate efficiently. A simple instance might be cited to illustrate what is in mind: The fiat went forth that maximum production was imperative and forthwith everyone forgot such things as holidays, but an individual required time off for urgent domestic reasons, and modestly made an appeal for leave. His employer at once acceded to his request, and even went further by giving him some advice and help in the particular circumstances that harassed him. Theoretically, a number of productive hours were lost; actually, production increased, and the reason was not far to seek. The other operators were definitely braced by the generous and spontaneous action of their chief; they gave of their best, and the *morale* of the shop improved. Had the "no sentiment in industry" fiend been in control, the answer would have been "orders is orders," no leave would have been granted, but at the same time a spirit of mute hostility would have been engendered, harmful to production, and only waiting the suitable opportunity for unpleasant expression. An atmosphere of understanding would soon banish the parrot cry, "There is no sentiment in industry."

Again, it is suggested that there are few senior engineers who have not heard it seriously asserted that "engineers are bad administrators." Some might have been inclined to subscribe to it temporarily when annoyed by the way in which assistants have mishandled their administrative problems, but on analysing the position it will be realised that such a statement is as misleading as it is mendacious. Men could readily be named who have not only proved their ability as practical engineers, but have also risen to the highest administrative positions, and held them with distinction. In the past, it was accepted in our own Civil Service that all administrative posts must be held by men who entered Government service by competitive examination after graduating at a recognised university. They were then posted to the so-called administrative grade, where by regular attention to their duties they were reasonably safe to rise to positions of responsibility. Even in this bulwark of constitutionalism it is now possible for the professional man to attain to the chief administrative post in his department. The engineer has perhaps only himself to blame for such a parrot cry being possible; perhaps it is because he is so interested in the technical side of his duties that he has paid but scant attention to the human one, and has neglected those opportunities that have come his way to widen his perspective. It certainly is true that many engineers have no leaning towards administrative work, but it would obviously be absurd from this to infer that engineers as a class are unsuited to the sphere of administration.

It is a well-known phenomenon that if a man stands stock-still and concentrates his gaze on the empty heavens, he will soon be surrounded by a number of his fellows similarly gazing into vacuity, wondering vaguely what it is that is attracting their attention. When the coiner of the phrase "poets are born, not made," expressed his opinion he little realised how soon it would be developed into a parrot cry to be plagiarised first by the artist, then by all and sundry. It might equally well be acquired by the engineer; indeed, there would be more truth in a parrot cry that "engineers are born, not made," than in the few other cries we have selected at random.

It is suggested that the engineer has been submitted to a fairly extensive training, and one that should help to render him impervious to lending an ear to these futile parrot cries. He has been taught to think logically for himself; he should be immune, but is he? We leave the issue with the reader.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

PRODUCTION PROBLEMS

Sir,—While fully agreeing with the main contentions of Mr. Hallett's letter, I submit that in common justice he should not have ignored two important facts:—

(1) That standardised designs have already been evolved for war-time factories, with a view to the saving of material and to facilitate rapid and economic erection, and,

(2) That steps have been taken to simplify the construction of machine tools. Incidentally, a number of firms which had never built machine tools before are now satisfactorily constructing them for use on mass production.

At the same time it is appreciated that much more might be done in the direction indicated by Mr. Hallett.

George W. Tripp,
F.C.G.I., M. Inst. C.E.

Bromley, Kent, August 3rd.

Hours of Work and Maximum Output

The following circular, with a Foreword by Mr. Bevin, has been sent to a large number of engineering employers.

Owing to the situation in this country following the collapse of France, it was necessary to call upon all those engaged on war production to make an intensive effort by working long hours to speed up production to the utmost extent. It is still of vital importance to maintain war production at the maximum. It is of equal importance, if this end is to be achieved, to relieve the strain on workpeople caused by long and continuous hours of work, and for this purpose an adjustment in the present long hours of work is essential. This is a matter which must be dealt with by firms in accordance with their particular circumstances, and not by a general order. In order to assist them, I have drawn up some notes for guidance—"Hours of Work and Maximum Production"—in consultation with the British Employers' Confederation and the T.U.C., and with the co-operation of the Supply Departments concerned. These notes are set out in the following pages, and I hope that any action necessary will be speedily taken.

The maintenance of maximum output on war production is essential. To achieve this, the hours of work must be adjusted to prevent tiredness. The continuation of seven-day working, with an average working week of between seventy and eighty hours, will quickly cause a rapid decrease in individual productivity owing to the abnormal strain. If prolonged, the output achieved in seven days will become less than what could have been achieved with the same group of workers in a shorter period. It is necessary therefore that the average hours of work should be reduced to a lower level, the ideal being the figure which will give, under existing conditions, the maximum output. It is not easy to determine this figure, which varies according to the circumstances of different industries, but experience shows that it is materially below the general hours at present being worked on war production. It may not be practicable to effect the necessary adjustment at once, in which case the immediate provision of adequate rest periods will assist in the prevention of undue fatigue.

In effecting the necessary adjustment it is essential to avoid any falling off in output—in fact, the objective must be continually increasing output. To achieve this and at the same time to reduce the working week, it is clearly necessary to take steps to increase the size of the working force so that the man-hours per week will not be diminished, but rather

increased. An overall reduction from the present level to some new level may mean a considerable increase in the labour force. The new labour required will, for the most part, have to be trained, and this takes time. The labour force therefore must be speedily increased, but whilst this is happening the strain on the worker must be relieved by an immediate reduction in hours. It may not be practicable to effect a reduction to the optimum hours immediately, in which case an interim arrangement must be put into operation. An illustration of a practical arrangement that would relieve the strain on workpeople during an interim period is given below.

First Week.—The day shift operates from 7.30 a.m. until 7 p.m. on four of the five days, Monday to Friday, and from 7.30 a.m. to 5 p.m. on Saturday and on the other day chosen for a stoppage at 5 p.m. during the week.

Meal breaks are 1½ hours (1 hour at mid-day and ½ hour for tea) for long days, making the actual hours worked 10½, and 1 hour on Saturday and the other short day, making the hours worked 8½—average working week, 58 hours.

Second Week.—The day shift operates as above from 7.30 a.m. until 7 p.m. on four of the five days, Monday to Friday, and from 7.30 a.m. to 5 p.m. on the short day in the week. On Saturday work ceases at 12 noon (no meal hour). Sunday work is continued from 8 a.m. to 5 p.m., with a break of 1 hour—average working week, 62 hours.

This cycle of hours is repeated, giving an average working week for the day shift of 60 hours.

The night shift operates from 7.30 p.m. to 7 a.m. on five nights a week, Monday to Friday, with breaks amounting to 1 hour for meals the actual hours worked being 10½ per night. A sixth night can be added fortnightly if production demands it.

In many establishments it is the practice to give 1½ hours for meals (1 hour at mid-day and ½ hour for tea) on the four long days. This would involve a reduction of only one hour in the working weeks shown above.

Until the necessary labour force has been obtained, relief workers should be called in where practicable to take the place of unskilled or semi-skilled workers on rest days—if possible, for two day and two night shifts. These relief shifts would, in addition, form a training squad for a new staff, if extensions are contemplated. Employers should seek the aid of the local Labour Supply Committee in regard to harnessing the services of relief workers.

As soon as the necessary labour force has been acquired and trained, steps must be taken to institute a permanent scheme to achieve the two primary purposes in view, which are :—

(*a*) A reduction in the working week to the optimum hours, which experience in many manufacturing fields shows to be in the region of 55 or 56 hours.

(*b*) An increase of man-hours and the productivity per man-hour.

There are various methods of shift and rota working that can be adopted for this purpose. One example, which is recommended, is given in the Annex.

It is of vital importance that there should be adequate breaks for all workers during which the management should endeavour to provide easy facilities for the workers to purchase refreshments likely to restore their physical and mental vigour. It is suggested that a break interval of 10 minutes duration might be introduced near the middle of the normal working period. For some cases other arrangements (for example, a break in each hour) may be preferable. The above paragraphs refer to the hours of men.

The hours of women and young persons are restricted by the Factory Acts, subject to such Emergency Orders modifying those restrictions as may have been made by the Secretary of State or may be made by the Minister of Labour and National Service. Firms desiring to employ women or young persons for hours not authorised by the Factory Acts or by any such Emergency Order which they already hold should approach the local factory inspector. Factory inspectors have been instructed that apart from such applications they should, as from August 1st, 1940, enforce the Factory Acts and the Emergency Orders.

ANNEX

The engagement of eight men to work three machines or to take the places of three men day and night for a day shift of 12 hours (10½ hours actual work) and a night shift of 12 hours (11 hours actual work) will give 150½ hours' work for the machines (or places) at an average working week for the individual of 56½ hours. A scheme for the first four weeks of such arrangement is set out below, and the rotation is completed in thirty-two weeks.

Three shifts of 8 hours is the best plan for heavy and hot work. If the work is so heavy that it is desired to reduce the 56 hours per week, the engagement of seven workers to do the work of six will reduce the average working week to 48 hours.

If women are engaged on hot and heavy work, and sufficient labour is available, the four-shift system reduces the average working week to 42 hours. In this system 8-hour shifts can be worked, and the arrangement that has been found best in practice is shown below, but other systems can be adopted to give longer turns on the same shift or to suit the convenience of the workers :—

1–6 = Regular men per machine.
RA–RB = Relief men for any of three machines.

	Machine 1.		Machine 2.		Machine 3.	
	Day.	Night.	Day.	Night.	Day.	Night.
Saturday ...	2	1	3	4	5	6
Sunday ...	RA	RB	3	4	5	6
Monday ...	RA	RB	3	4	5	6
Tuesday ...	1	2	RA	RB	5	6
Wednesday	1	2	RA	RB	5	6
Thursday ...	1	2	3	4	RA	RB
Friday ...	1	2	3	4	RA	RB
Saturday ...	1	2	3	4	5	6
Sunday ...	1	2	3	4	5	6
Monday ...	RA	RB	3	4	5	6
Tuesday ...	RA	RB	3	4	5	6
Wednesday	1	2	RA	RB	5	6
Thursday ...	1	2	RA	RB	5	6
Friday ...	1	2	4	3	RA	RB
Saturday ...	1	2	4	3	RA	RB
Sunday ...	1	2	4	3	6	5
Monday ...	1	2	4	3	6	5
Tuesday ...	RB	RA	4	3	6	5
Wednesday	RB	RA	4	3	6	5
Thursday ...	2	1	RB	RA	6	5
Friday ...	2	1	RB	RA	6	5
Saturday ...	2	1	4	3	RB	RA
Sunday ...	2	1	4	3	RB	RA
Monday ...	2	1	4	3	6	5
Tuesday ...	2	1	4	3	6	5
Wednesday	RB	RA	4	3	6	5
Thursday ...	RB	RA	4	3	6	5
Friday ...	2	1	RB	RA	6	5

A, B, C, and D represent the four shifts.

	6 a.m. to 2 p.m.	2 p.m. to 10 p.m.	10 p.m. to 6 a.m.
First week—			
Sunday	C	A	B
Monday	D	C	B
Tuesday	D	C	B
Wednesday	D	C	A
Thursday...	B	D	A
Friday	B	D	A
Saturday...	B	D	C
Second week—			
Sunday	A	B	C
Monday	A	B	C
Tuesday	A	B	D
Wednesday	C	A	D
Thursday...	C	A	D
Friday	C	A	B
Saturday...	D	C	B

And so on.

Heat Conduction in Refrigerating Machines

CALCULATIONS have been made by Mr. W. J. Peck and Mr. H. M. Edmonds, of Battersea Polytechnic, to investigate the possibility of effecting an improvement in the performance of vapour compression and other refrigeration machines by the substitution of suitable non-conducting material for the highly conducting metals now used for those parts of the machine where the temperature gradient is steep.

To obtain some idea of the magnitude of the heat quantities involved, heat balance sheets were taken from tests on a small ammonia machine. These showed discrepancies which might be explained either as being due to radiation into the machine or by heat conduction from the high to the low-temperature side. It should be noted that the heat conducted along the metal parts of the machine will itself not appear in the quantities measured in the evaporator and condenser, but only the heat equivalent of the additional work needed to transfer the leakage heat back from the low-temperature to the high-temperature sides of the cylinder and regulating valve. A sample heat balance is :—

	Per cent.
Heat equivalent of compressor indicated horse-power	22
Heat taken from refrigerated material	100
Total	122
Heat given to cooling water in condenser	145
Difference	23

The coefficient of performance (reckoned on I.H.P.) is 4·52.

The heat radiated into the brine system and evaporator, despite very complete lagging, probably accounts for the most serious part of the loss, although the heat radiated into the unlagged part of the low-temperature side of the machine is comparatively small—some 1·25 per cent. to 2 per cent. of useful refrigeration, according to the investigators' estimate. An attempt to obtain an approximate value of the heat conducted from the high to the low-temperature side through the metal gave various values according to the assumptions made, ranging from 2·5 per cent. to 16 per cent. of the useful refrigeration, depending on the temperature gradient and path of heat flow assumed.

The problem has also been approached from the point of view of the flow of heat into the refrigerant and the effect produced on the indicator diagram. As, however, there was available no means of directly measuring the rate at which the ammonia was passing round the machine, any drying effect of heat passing into the ammonia during the suction stroke due to heat leakage through the metal of the cylinder head could not be determined; the compression curve on the indicator diagram appears to conform to no law of the form $P V^n$=constant, and so the rate of heat reception during compression is equally difficult to estimate. There seems no likelihood of any phenomenal gain in efficiency being obtained, but as some of the "plastics" now available have the necessary wearing qualities and have conducting powers for heat much smaller than those of iron and steel, the substitution of such a material would possibly result in a small gain in refrigerating effect. Whether this gain would justify the change can only be determined by trial, as the problem does not appear to lend itself readily to calculation.

American Engineering News

Pulverised Coal Boiler Plant

The power station of the electric company at Boston has been noted for its battery of four boilers worked at 1400 lb. pressure, but increasing demands necessitated an increase in their steaming capacity. By changing from stoker-fired coal to pulverised coal it was practicable to obtain a marked increase in furnace volume and in area of water-cooled furnace wall. These changes, with alterations in draught equipment and auxiliary apparatus, increased the total output from 760,000 lb. of steam per hour to 1,200,000 lb. Conversion to pulverised coal made it necessary to provide more effective means for collecting flue dust, and this was effected by installing electrostatic precipitators on the roof of the station. Each precipitator has a dust hopper of 20 tons capacity, fitted with vibrators and with rotary feeders to discharge the dust into a 6in. pneumatic conveyor. The boilers have 10-ton ash hoppers lined with firebrick and insulating brick. The weight of the precipitators and the induced draught fans made it necessary to reinforce the steel columns of the building, and the roof was raised 16ft. to provide a new floor for the fans and their connections. Such changes necessitated careful design and execution. The fans are motor-driven units with a capacity of 190,000 cubic feet per minute of flue gas at 440 deg. Fah., and each is driven by a 1250 H.P. motor. With removal of the stokers and lowering of the furnace floors, inclined downward towards the ashpit, the combustion chambers were enlarged to 28ft. wide and 18ft. long. Over each pulveriser is a 5-ton bin fed by spouts from the overhead bunkers, these bins providing a thirty-minute reserve supply in case of stoppage in the spouts. Each boiler has two pulverisers under the inclined floor of the furnace, each having a capacity of 10 tons per hour. Six combination coal and oil burners are mounted in a wind box with damper control; both steam and mechanical atomisers are provided for the oil burners. Furnace pressure controls the induced draught fans, while steam flow controls the forced draught fans and the feed of pulverised coal.

A Large Coal Shipping Plant

Characteristic of American railway practice is the development of handling and transporting bulk freight rapidly and at low cost. A recent instance is the construction of a coal shipping plant by the Pennsylvania Railroad at Sandusky. Rapidity in loading ships is essential as navigation on the Great Lakes is closed for four or five months and coal must be shipped for storage at distributing points at the head of the lakes. This new plant, which supplements two older plants, is designed to discharge sixty trucks per hour, each truck holding from 50 to 100 tons. An electric locomotive pushes trucks from the yard to an incline of 1 in 6½, up which each truck is moved in turn by a cable-operated "barney," the truck landing on the platform of a cradle or lift in a steel tower 118ft. high. The truck is automatically locked and then raised at a speed of 200ft. per minute and tilted sideways to discharge its contents. It is then tilted back, lowered, pushed off the cradle by the next loaded truck, and runs down an incline of 1 in 14 to the empty truck yard, where its speed is controlled by truck retarders or track brakes. Coal from the truck falls into an inclined triangular pan, 67ft. wide at its base on the tower and 5ft. at its apex, where a hole 4ft. square allows the coal to fall through a telescopic pipe or chute whose bottom is in the hold of the ship and is filled with an automatic trimmer. To prevent excessive breakage of coal the pan is fitted with baffles faced with rubber, and the chute is kept full, so that the coal flows and slides instead of falling. The round trip of the truck pusher is made in fifty-five seconds, and the cradle cycle is forty-eight seconds, leaving seven seconds for spotting the truck in position on the cradle. There are three operators: one near the tower to control the barney, the track brake on the cradle, and the starting of the cradle; one in the tower to control the cradle, slope of pan and sprinkling device; and one in a cabin at the apex of the pan to control the chute and coal-trimming device. All operations are effected by electric motors.

The Engineer

AUGUST 9, 1940

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HOURS OF WORK

THE ideal of the workman about half a century ago was "eight hours work, eight hours play, eight hours sleep, and eight bob a day"—a programme which then seemed as far out of reach as it was attractive. Actually in times of peace, although night shifts may sometimes be necessary, and although they have great economic advantages, yet we are better without them, for when all is said and done, there is something unnatural about night work. On the other hand, when we become engaged in war, and particularly in a war like this, in which all other values shrink to nothing compared with the inexorable necessity of immense mechanical construction, then it is surely elementary to use such means of production as we have to the fullest extent of their capacity while continually adding to them as well.

The main difficulties in getting night shifts going were, it will be remembered, the opposition of the unions and the equally determined attitude of the Home Office towards maintaining certain restrictions which prevented full use being made of female labour. When, however, a number of Labour leaders were given office in the Government, most of the opposition and restrictions were withdrawn, and there is no doubt that Mr. Bevin has encouraged labour to give of its utmost. In the great crisis with which he found himself confronted, he called for an extraordinary effort and for working hours of unexampled length, including week-ends and Sunday work and the cutting out of holidays. In the circumstances he was right, and there is no doubt that as a result production was greatly speeded up. But one cannot run a mile at a speed of a sprinter, and it was obvious to all in touch with the workers that the pressure was too great to keep up. Hence the circular, reprinted on another page, which the Ministry of Labour has sent to manufacturing firms all over the country. On the question as to what really is the most economic length of a working week, there are many and conflicting opinions. Somewhere or other in the scale of hours is to be found that critical point which will give the best production at the least cost, but not even the psychologists are quite sure where this optimum resides. What we do know is that if the human machine is stressed beyond a certain degree, it begins to adjust itself and to slow down the rate of production. This is part of Nature's scheme of self-preservation. How often has the enthusiastic amateur gardener watched the professional at his steady pace, and has said, "Oh, let me have a try" and has taken the spade. He starts off gaily enough at 50 per cent. faster than the professional, but in about half an hour wearied muscles impel him to give the spade back to the professional, who has learned from years of experience that if he is to stay the course his only chance is to keep within the bounds of reason. When a job is more or less purely mechanical and consists in watching an automatic machine which produces a definite number of units per hour, then there is no doubt that a long day produces far more than a short day, and this is rather strikingly brought out in departments engaged on repetition jobs. Here, the effect of working the extremely long hours, plus week-ends, has been to put up the output almost, but not quite, in proportion to the extra time worked. Even so, the cost per piece has slightly increased. But where there is a much greater proportion of manual work, especially among fitters and erectors, although there has been a marked increase in output due to the longer hours, yet the balances earned by the pieceworkers have tended on the whole to be less, which shows, of course, that their rate of production per hour has been slowed down. On the question of two shifts *versus* three shifts, we are in full agreement with Mr. Bevin that the three-shift system is the best of all; it enables the plant to be run continuously on shifts of eight hours each, though, of course, we still have the meal-time breaks. It has advantages, too, in making the problems of transport of labour easier. But when the limiting factor is the quantity and quality of labour available, it is obviously impossible to man three shifts, save in exceptional cases or in exceptional trades, and there is little doubt therefore that the two-shift is the best method to-day. Even so, manufacturers have the greatest difficulty in getting sufficient labour to keep the whole of their plant running on the night shift. It is very rarely that less than one-third of the machine equipment is not idle at night, but, of course, it is not practical to work all machines at 100 per cent. of their time, because in all shops there are certain machines which can accomplish all that is required of them in a single shift. If the number of new machines put down had been smaller, we should probably have got further towards continuous working of the machines already in existence, because every new machine means labour to run it, and it is always easier to find workmen for day shifts than for night shifts.

We expect, then, reviewing the whole matter, that the circular of the Ministry of Labour will be generally approved by employers, and the public may be confidently assured that the best practicable use is being made of our machine power and available labour. The position is vastly improved since the early months of the war. Restrictions have been removed and the only weak link in the chain is the lack of an adequate supply of skilled labour. That is being overcome by intensive training in the special establishments run by the Government and by the excellent systems which exist in many works. Hence if the war continues for long, our position in that respect is certain to improve rather than to deteriorate. The task before the Ministry of Labour was to make the best use possible of the labour available, and, having recognised that the enormous and magnificent effort put up to meet an exceptional emergency could not be kept up indefinitely, it has set about the organisation of a scheme that will enable factories to maintain a high level of production for as long as may be necessary. The return of the week-end break and the reduction of average hours over two weeks to sixty has the approval of the British Employers' Confederation and the Trades Union Council, and we have no doubt that the scheme as detailed will be loyally accepted by employers and employed alike.

Science in War

EVER since John Perry, many years ago, proclaimed "England's Neglect of Science," a perpetual under-current of national self-depreciation has been punctuated by direct attacks on the British attitude towards science. The latest manifestation of this kind is a sixpenny book—a "Penguin"—which has already received much attention and is likely to be very widely read and quoted. It was written, the reader is informed, "by 25 scientists, all of whom speak with authority in their own fields," who met "round a dinner table less than a month ago." Unhappily, the publishers do not give the names of the authors and the public is deprived of the opportunity of deciding for itself the merits of those whose views are advanced. The omission is a serious one in this case. With few exceptions the authority for statements is not given; we have no means of knowing whether they are accurate or not, and have to put our trust in the integrity of the authors. Whenever that occurs it is, we submit, the proper course to give the name of the author so that the reader may be in a position to estimate the value of his opinion from his previous history. It was more than ever necessary in this instance, because in some chapters there is an unmistakeable evidence of political bias, and we believe we can trace here and there editorial touches which impart the same flavour to essays which were originally free of them.

It is this political background which distinguishes this volume from others of the same kidney which have preceded it. Earlier authors have been content to condemn England's neglect of science in general terms. The present twenty-five lay the blame on the Government. That is very typical of the trend of thought of to-day, which leans more and more towards the replacement of individualism by State organisations. In fact, science as meant by the "Twenty-five" is not so much science in the familiar understanding of the word whenever it is spelt with a capital "S" as State organisation. Science is described, if not precisely defined, as "the most orderly expression of normal ways of acting and thinking," and we are assured that had the world paid more attention to the uses to which scientific advances are put and "had scientific methods played their part in home and international affairs, war might have been avoided." Unless this aspect of the book is grasped its meaning and purpose will be misunderstood. It is not, like its predecessors, an attack on science and technology so much as a prolonged argument for organisation and for the more profitable employment of scientific knowledge by deliberate planning. When the publishers proclaim, as they do on the cover, that "The full use of our scientific resources is essential if we are to win the war. To-day they are being half used," they do not mean that we are neglecting science so much as that owing to the failure to "plan" we are not making the most of our knowledge and abilities. And it must be ever remembered that "science" is used in the most liberal sense to cover any activity which may be directed by logical thought. For example, we are informed that science "has hardly been used, at least by us, on the more general, and the more vitally important questions of strategy and tactics. . . . There is little doubt that geographic and economic knowledge, and the assistance of great modern developments in mathematics, could lead, in a minimum of time, to a revolution in strategy far greater than that introduced by Napoleon." We can only understand by such assertions as this that, in the

opinion of the "Twenty-five" the "scientists" whose business it is to study war and all its complications are less fitted for their purpose than other scientists who are called geographers, economists or mathematicians. It would be of great national service if these geographers, economists and mathematicians would draw up a plan of campaign which would revolutionise our present strategy so effectively that the enemy would be defeated before he had time to grasp that a new secret weapon had fallen upon him.

When we turn from the general to the particular we find that the "Twenty-five" are less well-informed than critics ought to be. They are clearly not completely conversant with the work of the D.S.I.R. and of the great technical and scientific institutions and appear to be ignorant of much of the scientific work that is being constantly performed for and by the Services. To some of them it would seem that the mere fact that research is carried out with a profit-making motive is sufficient to damn it out of hand. But despite a few examples given in a spirit of concession rather than of conviction we do not think the "Twenty-five" have any sincere interest in the scientific technology of war material *per se*. By Science they mean and understand the organisation of all the resources of society, preferably, we gather, by the State. But as their attitude towards State departments is, in general, "See what they are doing and tell them they mustn't," they leave us in no little doubt about how organisation is to be effected. If it is to be taken out of the hands of those who have made it their business to know—who make their living by knowing—and delivered over to an elected House of Commons, success cannot be confidently expected. Perhaps the "Twenty-five" have in mind a Parliament or Standing Council of mixed scientists, who would settle *all* the home and foreign affairs of the country by geography, economics and "the great modern developments in mathematics."

Air Force Targets in Germany

No. III

(Continued from page 61, July 26th)

EMDEN AND WILHELMSHAVEN

IN our preceding article we dealt with the Dortmund and Ems canal, which forms one of the main inland waterways connecting the Rhineland and the Ruhr industrial areas with the ports and naval bases of Emden and Wilhelmshaven. In the accompanying map, Fig. 1, are shown the principal inland waterways of Northern Germany, showing the network of canals which connect the central and western areas of Germany with the principal ports and naval bases on the northern seaboard, including Emden, Wilhelmshaven, Bremerhaven, Cuxhaven, and Kiel.

During the past few weeks aircraft of the Bomber Command, although opposed by heavy anti-aircraft fire and balloon barrages, have carried

FIG. 1—CANAL SYSTEM OF NORTHERN GERMANY

out repeatedly successful attacks on important sections of the canal system and on the ports of Emden and Wilhelmshaven. Some account of the history and development of these two important naval bases will therefore be of interest to our readers. As centres of trade and fishing, their history goes back many centuries, but their rise into positions of importance as seaports and naval dockyards took place in the middle and latter years of the nineteenth century, and coincided with the planning and the completion of the Ems and Jade canal in 1889 and the Dortmund and Ems canal ten years later. Originally chosen on account of their natural advantages, these two ports give excellent shelter from the prevailing westerly winds and they may be said to possess a favourable strategic position, being well served with supplies from railways and canals. The channels and sea arms leading to the ports suffer much from silting, owing to the large amount of silt deposited by the rivers, and in order to create the necessary berths and anchorages for the larger ships important dredging work was carried out, and must be continued. In both ports extensive dock and harbour works have been effected, and in this connection it is of interest to record that in 1856, when the German Admiralty decided to develop the port of Wilhelmshaven as a naval base, Mr. J. M. Rendel, of London, was appointed to consult on the scheme with Geheimrat Oberbaurat Hagen, of Berlin.

THE PORT OF EMDEN

As will be seen from the engraving Fig. 2, Emden, Germany's most westerly port, is situated on the estuary of the River Ems, at a point opposite the Dutch province of Gröningen, quite near the frontier line between Germany and the Netherlands. The main channel passes from the North Sea to the south of the island of Borkum, which forms one of the Frisian group of islands, of which the others are Juist, Norderney, Baltrum, Langehoog, Spiekerhoog, and Wangerhoog. These islands, which stretch along the coast from almost the mouth of the Ems to the Weser and the Jade entrance to Wilhelmshaven, have been utilised as seaplane bases, and have also suffered from British air attacks. Before the port of Emden was taken over by the State in 1879 it was, up to 1848, an open harbour, subject to the ebb and flow of the tides. At that time the main waterway was in the city near the Rathaus, and it only allowed comparatively small ships to use the berths, the depth of water being from 11ft. to 13ft. By 1849 the depth of the water had been increased by dredging up to depths between 13ft. and 18ft., and the port had been further developed in those parts nearest the city and the railway terminus. In 1880 a straight inner and outer entrance channel were built, divided by sluice gates, the inner channel, leading to the main harbour berths and the railway dock, having a depth of 16ft. In the succeeding years further improvements took place, and with the opening of the Dortmund and Ems canal in 1899 reconstruction was begun and was completed in 1901. The new harbour works comprised wider inner and outer waterways, connected by a new deeper and wider lock, the old protective sluice gates being retained. In particular, the outer channel was developed, and berths were built at the side of the waterway. They included buildings and a berth served by ten 3-ton cranes, with railway connections to the inner and canal harbours and the city of Emden. Depths at the berths were increased up to 33ft. to 38ft., and the new lock between the inner and outer harbours was given a depth of 40ft., that being the depth of the main dredged channel. In the inner harbour three branch berths set at an angle to the main channel were constructed on one side, and on the other a large harbour for dealing efficiently with the barge traffic transported by the Dortmund and Ems and the Ems and Jade canals was constructed and equipped. At the outbreak of the last war the docking facilities at Emden included two floating docks in the inner harbour, one having a capacity of 3500 tons and

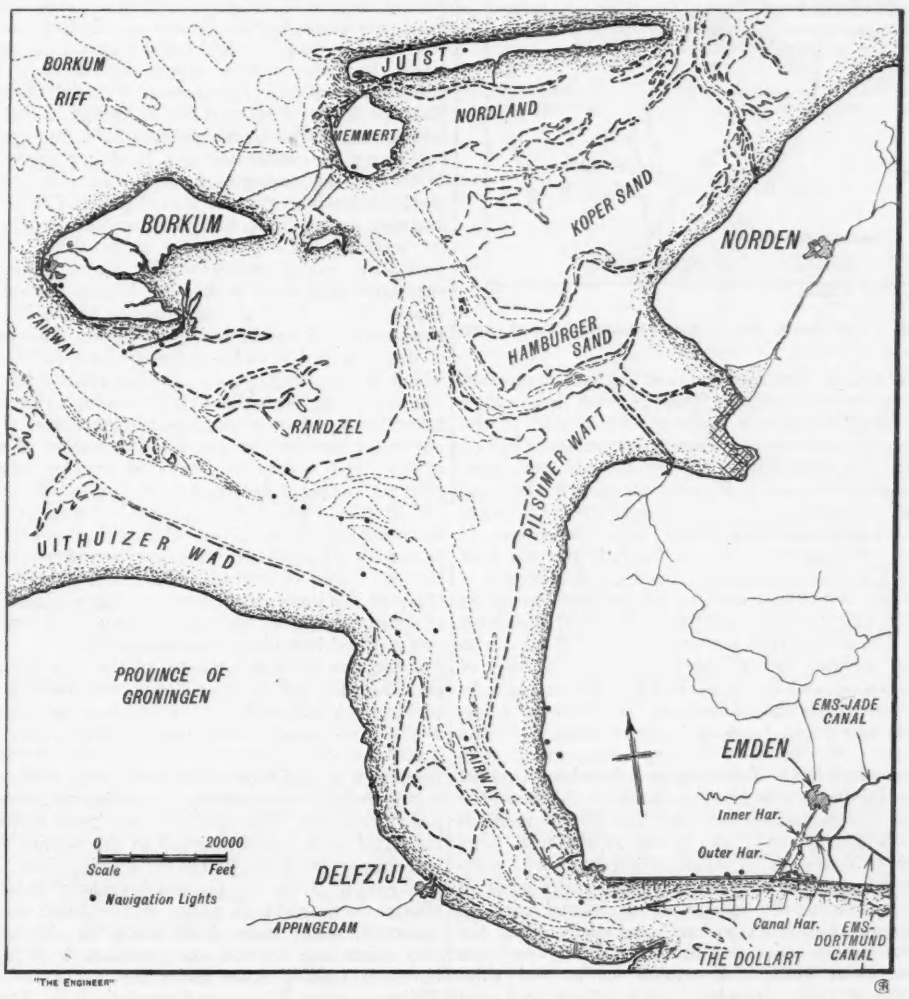


FIG. 2—ENTRANCE TO EMDEN HARBOUR

the other 2500 tons. During the ten years prior to 1914 there had been a marked increase in the quantity of coal from Westphalia, shipped to Emden by the canal system, and arrangements were made with both the North German Lloyd and the Hamburg-Amerika lines to coal at Emden, both the large passenger liners and the cargo ships of those companies. Suitable coal-tipping plant was installed and coal bunkering stores laid down.

As oil firing became increasingly adopted for naval and mercantile ships, oil bunkering facilities with well-planned storage tanks were added. After the last war the importance of Emden as a naval base somewhat declined, but in recent years it has been revived with the rebuilding of the German Fleet, and the amount of traffic passing through the port has been further increased by the carrying out of recent schemes for the widening and deepening of the canal systems, which have again brought the port of Emden into a position of prominence.

Wilhelmshaven Naval Dockyard

It was about the year 1848 that, with the establishment of the German Navy, attention was called to the urgent need for a suitable naval dockyard and base. In that connection the small village of Heppens, to the north of Wilhelmshaven, was first mentioned. Among the reasons then advanced for choice of this site were the good navigational conditions in the Jade waterway and the Jade Bay (see Fig. 3), a clear entrance, good anchorage

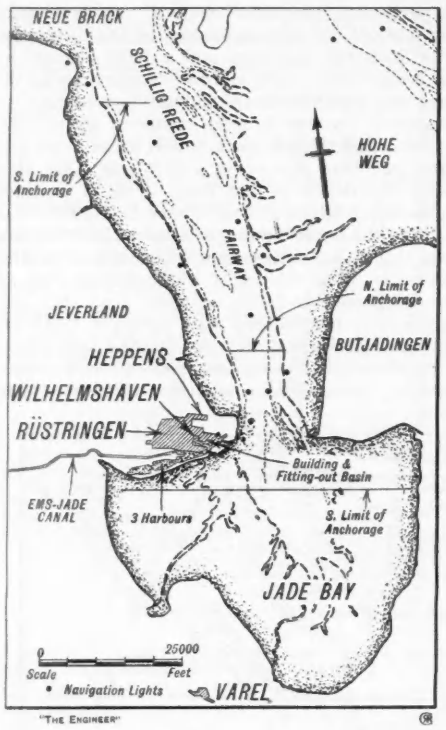
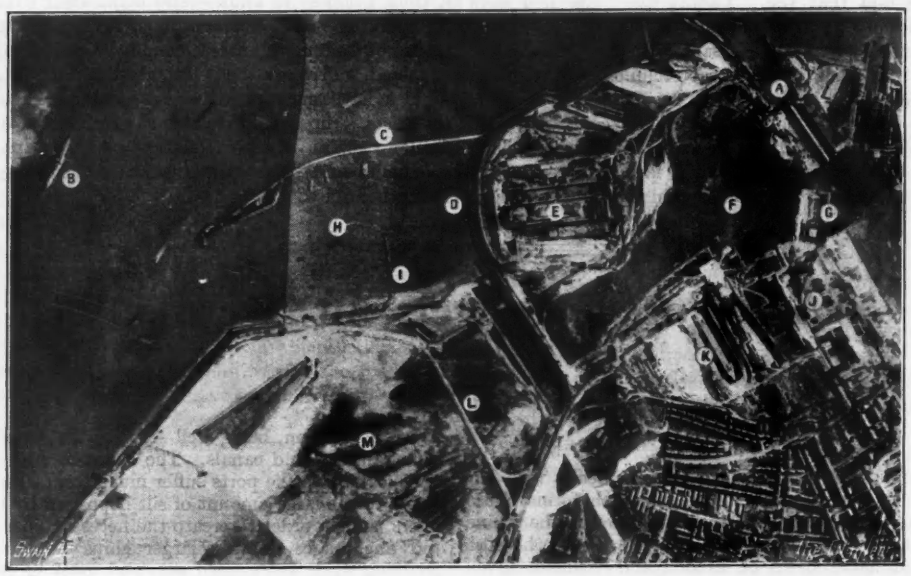


Fig. 3—Entrance to Wilhelmshaven Dockyard

over a large stretch of the inlet channel, protection from westerly winds, freedom from ice, and a favourable strategic position with regard to the other river estuaries. Further advantages claimed were the possibilities of easy defence, no interference with naval ships by mercantile shipping, and adequate supply arrangements from the railway and canal connections. These conditions, it was held, made the site on the Jade Bay the best possible for the laying down of a naval dockyard.

The first constructional plans were made in 1856, and were drawn up for the Prussian Admiralty by Geheimrat Oberbaurat Hagen, of Berlin, who was assisted by Wasserbaudirektor Hübbe, of Hamburg, and Mr. J. M. Rendel, of London. So well were the site studied and the plans drawn up that the original scheme formed, with but little change, the basis of developments, which were completed in the following two decades. In 1867 the railway connection was made to the new yard and the station opened, and in 1869 the name of "Wilhelmshaven" was given to the new base. By 1873 the naval construction yard was completed and was connected to the south point of the peninsula by means of a channel with an entrance lock. Extensions were made during the next twenty years, and by 1900 a fitting-out basin had been built, the engine works and shipbuilding yards extended, and a railway and road connection made with the Ems and Jade canal, which runs almost parallel with the south coast of the peninsula. During the period between 1900 and 1921 further works were planned and carried out, which included the construction of three new harbours to the south. The largest harbour is that nearest the new connecting harbour close to the fitting-out basin, which had already been completed in 1900, and had, leading into it, a second entrance to the main basins. Connected with the new Large Harbour and to the west of it is the Middle Harbour, and still further west the West Harbour, in which the shipbuilding yards works at the West Harbour was erected and operated for some years by the Deutsche Werke A.G. By 1930 that firm had ceased to build ships at Wilhelmshaven, and by 1934 the whole of the dockyard was returned to the German Admiralty. Much remained to be done in order to bring the base up to full service requirements, and new extensions were planned, and large oil depots laid down. The engraving already referred to, Fig. 4, shows clearly the nature of the extensions now being made to the eastern section of the dockyard, adjoining the Jade entrance inlet—see Fig. 3. In



A. Existing entrance to harbour and lock gates.
B. Capital ship.
C. New mole.
D. New entrance to harbour.
E. New locks under construction.
F. North harbour.
G. Coffer dam.
H. Dredger in operation in future channel.
I. Pipe line.
J. Barracks.
K. New dry dock under construction.
L. Causeway carrying light railways.
M. New area under reclamation from the sea.

Fig. 4—New Construction, North Harbour, Wilhelmshaven

and engine works of the Deutsche Werke A.G. were built at a later date. At the back of these three new harbours a large canal harbour was constructed, with coal storage facilities and at a later date an oil tank installation. To the west of these three harbours in the direction of Bant and Mariensiel new railway and canal connections were made, and an artillery depot laid down. An important structure at the eastern end of the Large Harbour is the Kaiser Wilhelm Bridge, a swing bridge with double arms, giving a 32ft. free opening above the waterway and having a span of 262ft. for the passage of ships. In the Large Harbour special berths for the reception of torpedo destroyers were built, and facilities also provided for berthing and repairing the larger ships. The dockyard was now served by three harbour entrances with their locks, the largest having a depth of over 38ft. giving entrance to the North Harbour and the main fitting-out basin. This part of the dockyard was chosen for the later additions which are now being made, and are illustrated by engraving, Fig. 4, which is a photograph recently taken by one of our reconnaissance machines. The power for the dockyard and the operation of the bridges and cranes is generated in two power stations having a designed total output of about 16,750 kW. One of them is a turbine station and the other oil engine driven, while a third source of power is from the overland power lines which serve the Jade area of supply. The water supply for the port has been solved by the sinking of a series of artesian wells which have filtering plant, water being stored in underground reservoirs.

After the feverish activity of the last war, a period during which several important extensions to the dockyard and the shipbuilding and engine works were made, there came during 1919–24 a period of disuse, owing to the difficulty of transforming a specially built dockyard to the different requirements of the mercantile marine and peacetime industries. The part of the dockyard utilised for naval work was restricted to the central and eastern part, and the 40,000-ton floating dock was delivered to Malta. In the south-westerly sections efforts were made in parts of the three south harbours, other than those fitted for destroyer and submarine service, to establish a sort of industrial trading estate under the direction of the Wilhelmshaven-Rüstringer Lagerhaus A.G. Under that direction a mercantile shipyard and engine

the main they consist of a reclamation scheme and the provision of a new harbour entrance, protected by a mole. The legend below Fig. 4 gives details of the work which is now being carried out.

In conclusion, we would express our indebtedness to the Hydrographer of the Navy and the Controller of H.M. Stationery Office for permission to base our drawings, Figs. 2 and 3, on British Admiralty charts, and to the Air Ministry for the use of the British official photograph we reproduce in Fig. 4.

Obituary

JAMES SCOTT KINCAID

The Clyde marine engineering industry has lost an outstanding personality by the death, on Tuesday, July 30th, at his home, "Brannochlie," Bridge of Weir, Renfrewshire, of Mr. James Scott Kincaid, the chairman and managing director of John G. Kincaid and Co., Ltd., of Greenock. The company, it may be remembered, was founded by his father in 1868, and for many years was engaged in the manufacture of reciprocating steam engines and marine boilers. In 1916, on the retirement of his father, Mr. James Kincaid took over the establishment and began to modernise the shops and equip them to meet the post-war demands for marine propelling machinery. While continuing the manufacture of marine engines and boilers his firm also undertook the construction of marine oil engines under licence from Harland and Wolff, Ltd. In 1919 the works of Caird and Co. in Arthur Street, Greenock, were taken over by the firm and utilised as an extension for the production of steam engines and boilers. The larger works in East Hamilton Street were rebuilt and laid out for the construction of Burmeister and Wain type oil engines. The foresight exercised by Mr. James Kincaid was fully justified, and the business of the firm in all kinds of propelling machinery rapidly increased. In 1938 no less than 96,125 I.H.P. of engines was completed, of which oil engines aggregated 56,000 H.P. and steam engines 40,125 H.P. About 1933 the firm entered into an agreement with the Kromhout Engine Company in the Netherlands to construct Kromhout oil engines for

marine and land services. Three years later, however, it produced a new type of oil engine of its own design, which was installed in the motor vessel "Kindiesel," which was built by Ardrossan Dockyard, Ltd., and operated by the Kindiesel Shipping Company, Ltd., in which Messrs. Kincaid had an interest. Apart from the work connected with the running of his own concern, Mr. Kincaid found time for many other business interests, and he was a director of the Ardrossan Harbour Board, Ardrossan Dockyard, Ltd., and William Baird and Sons, Ltd. For many years Mr. Kincaid was a trustee of Greenock Harbour, and he also served as a director of the Greenock Chamber of Commerce. He was Vice-Chairman of the Marine Engine Builders' Association and was a valued member of the management and the technical committees of the British Corporation Register of Shipping and Aircraft. He had a wide circle of business and private friends, who felt a sense of deep loss on hearing of his sudden death on the evening of July 30th, following an afternoon at business in Glasgow. His enterprise, ability and his cheery personality will long be remembered.

PROFESSOR WILLIAM FRECHEVILLE

MINING engineers throughout the world will learn with deep regret of the death of Professor William Frecheville, which took place at his home, "Horse Block Hollow," Cranleigh, Surrey, on Tuesday, July 30th, at the advanced age of eighty-six. He was born in Nova Scotia, and was educated at the Royal Naval School at New Cross, the Technical School at Berlin, and the Royal School of Mines, London. He graduated from the Royal School of Mines in 1875, and from 1875 to 1889 he was engaged in managing mines abroad, and from 1889 to 1912 in examining and reporting on mines in various parts of the world. He was an Emeritus Professor of the Imperial College (Royal School of Mines), having been Head of the Department of Mining from 1912 to 1919. He was also the first Professor of the School of Mines in its present building, and a Governor of the College from 1914 to 1919. While he was Professor at the Royal School of Mines he founded, with the aid of an exceptional collection of safety lamps bequeathed by Professor Cooke, a collection of rare minerals bequeathed by Professor Cox, and a large number of gifts sent by old students, a very fine museum in the Mining Department. From 1912 to 1932 he was a Governor of the School of Metalliferous Mining, Camborne, Cornwall. In 1915 he was elected President of the Royal School of Mines (Old Students) Association. Professor Frecheville was made a Fellow of the Imperial College in 1932, and he was among the first to receive this distinction.

His wide professional experience enabled him to make numerous contributions to the "Transactions" of the Institution of Mining and Metallurgy, of which Institution he was President in 1904, Honorary Member in 1919, and Gold Medallist in 1926. In addition, by generous gifts for awards standing in his name, including the Frecheville Fellowships, he actively furthered research and education in mining and metallurgical science. His exceptional activity to the last cannot be better illustrated than by the tour which he made, at the age of nearly seventy, of the platinum fields of South Africa. He travelled during the tour in a covered wagon, accompanied by one of his daughters, who acted as his secretary, thus enabling him to make his reports on the spot. In spite of his wide knowledge of practical mining, he found time to specialise in ore dressing, and was responsible for considerable improvements in practice.

Professor Frecheville enjoyed a world-wide reputation both as an expert and a teacher, and students of his may be found in all the mining quarters of the two hemispheres. He was much loved and admired by all who had the privilege of knowing him.

FIRE EXTINGUISHERS.—A warning issued by the Ministry of Home Security states that the attention of the Ministry has been drawn to the sale to the public for use as fire extinguishers of appliances which are frequently described as "bombs" and which consist of a quantity of liquid in a small glass globe. Although these appliances may be effective in dealing with ordinary fires, they cannot be relied upon as a means of extinguishing incendiary bombs. Moreover, some of them are filled with a fluid which would generate a poison gas if brought into contact with an incendiary bomb, and so would be very dangerous to use in a confined space in which an incendiary bomb was burning.

Pressure-Resisting and High-Duty Iron Castings*

By J. L. FRANCIS, A.M.I. Mech. E.

MANY things militate against the production of sound castings, even when conditions and circumstances under which they are made are normal. With the country at war, abnormal conditions prevail, making the usual difficulties greater and imposing others at a time when foundries are required to give a maximum output produced regularly to schedule. In order to prevent disorganisation of programmes, castings must pass into service with the utmost despatch. Castings which are obviously wasters on knocking out are bad; those with defects revealed only after machining are worse; but worst of all are the ones which have to be rejected after water pressure testing, when in the majority of cases machining operations have been completed. In these times work which has to be repeated is not only a loss of time and money, but places an extra burden upon men and machinery already working to the limit of capacity.

Before proceeding to deal with typical high-duty and pressure-resisting castings, the problem of providing correct metal for the work may be considered. This aspect of the matter is not least in importance or effect. Here again the point of maximum adaptability arises, and the metal practice evolved by the author has to cater for castings of diverse weight, size and type. Simplicity of operation is an asset in most spheres of activity and is particularly so with regard to founding. Consequently grades of pig iron and scrap should be kept to a minimum and the number of different metal mixtures made as few as possible.

The system to be described has been worked out to embrace straight and alloyed grey iron castings, weighing from a few ounces to 2 tons. Excepting flywheels, which are not pressure-resisting castings, the work cannot be termed heavy. Most of it enters into the medium or light category. Metal sections range between $\frac{1}{16}$in. and 1$\frac{1}{4}$in. thick; hence the problem occasioned by excessive slow cooling of massive sections yielding coarse-grained structures is not often met. Occasionally it becomes necessary to make castings of size, weight and section beyond that stipulated, but in any case they are required for machines which for the most part must conform to exacting conditions of service.

Pistons, cylinders, liners and valve covers form a class wherein resistance to pressure and wear is of paramount concern. Working pressures in some instances rise to as high as 3500 lb. per square inch. For these castings ease of machining is of secondary consideration. Intricate coring and wide sectional variations obtain to form water jackets and air spaces. Moreover, no leakage must take place between the water and air. Briefly the castings are of just the kind most difficult to make sound and for which this property is of supreme moment.

Systematic working and production of standard grades of iron having constantly uniform chemical and physical properties cannot be attained without efficient chemical and metallurgical control. Indeed, such control forms part of the very foundation upon which progress in the founding of sound castings has been built up. Pig irons and other components of the furnace charges must conform to specifications. On delivery, representative samples are taken and tested to ensure that the materials comply. Once standard analyses are established for given classes of work they should be maintained reasonably constant. Distinct grades of cast iron possessing known and reliable physical data facilitate calculations involved in design. Agreement as to the effect of design on casting soundness is unanimous, hence anything tending towards simplification of design is a good step in the desired direction.

The term "high-duty iron" used in these notes refers to material able to fulfil the requirements of British Standard Specification No. 786 (1938), which covers a tensile strength of from 15 to 22 tons per square inch obtained from the 0·875in. diameter

TABLE I.—*Raw Materials Used*

Material.	Mark.	Chemical specification, per cent.					Remarks.
		T.C.	Si.	Mn.	S.	P.	
Pig iron	A	3·25 to 3·50	3·50 to 4·00	1·75 to 2·00	0·04 max.	1·00	Soft foundry
Do.	B	3·50 to 4·00	2·50 to 3·00	0·75 to 1·00	0·03 to 0·04	0·25 to 0·50	Scotch
Do.	C	3·00 to 3·25	1·25 to 1·50	1·25	0·05 to 0·07	0·50 max.	Cylinder
Do.	D	3·00 max.	1·00 to 1·30	1·25 to 1·50	0·06 to 0·08	0·50 max.	Refined
Do.	E	3·00 max.	1·80 to 2·20	1·25 to 1·50	0·06 max.	0·45 max.	Refined
Foreign scrap	F	3·50	2·00	0·50	0·10	0·75	Average composition
Returns: Grades 1 and 2	G	3·30	1·80 to 2·25	0·80	0·80	0·80	Composition varies according to proportions, Grades 1 and 2
Returns: Grades 3, 4, and 5	H	3·10	1·45	0·85	0·10	0·50	Composition varies according to proportions, Grades 3, 4, and 5
Alloyed returns	J	3·10	1·45	0·85	0·10	0·45	Alloy content according to additions made
Steel scrap	K	0·30	0·10 to 0·20	0·50	0·05	0·05	Average composition

TABLE II.—*Material Covered by the Paper*

Grade.	Cupola charge per cent.	Chemical analysis, per cent.					Physical tests.		Suitable to meet specification.	Suitable for casting.
		T.C.	Si.	Mn.	S.	P.	Tensile.	Transverse.		
							Tons per sq. in.			
1	30 A 30 F 40 G	3·3	2·3	0·75	0·08	0·85	12·0	24·0	B.S.I. No. 321 (1938) Grade "A", 0·875in. dia. bar	Bed-plates, standards, pulleys, machine tools, small details and fittings to withstand no wear. General purpose castings of light section
2	15 B 15 D 20 F 40 G 10 K	3·25	1·70	0·70	0·08	0·65	14·0	25·5	British Admiralty, 13 to 14 tons per sq. inch, 0·875in. dia. bar	Fly-wheels, crank cases, covers, gear cases, small compressor bodies, cylinders where liners are fitted. Medium-sectioned castings not required to withstand high working pressure
3	25 A 25 D 40 H 10 K	3·20	1·65	1·0	0·10	0·55	15·0	26·5	B.S.I. No. 786 (1938) Grade I, also British Admiralty, 14 tons per sq. inch, 0·875in. dia. bar	Cylinder covers, heavy fly-wheels, pistons, steam cylinders, parts in sliding contact and all castings similar to above needing a tighter metal giving more wear and pressure resistance
4	20 C 30 E 40 H 10 K	3·0	1·4	0·95	0·10	0·45	16·0	28·0	B.S.I. No. 786 (1938) Grade I, also British Admiralty, 16 tons per sq. inch, 0·875in. dia. bar	Cylinder liners, H.P. covers, rotors, crossheads, water-jacketed castings and castings of heavy section to meet heavy wear and pressure conditions
5	20 E 30 C 40 H 10 K	3·0	1·15	1·0	0·10	0·45	17·0 Higher tests with alloy additions	30·0	B.S.I. No. 786 (1938) Grades II and III, 0·875in. dia. bar	Castings as above and those required for specially severe working conditions

* From a paper presented before the Institute of British Foundrymen.

cast bar, machined to 0·564 square inch section.

All the iron is melted in cupolas fitted with receivers. Melting practice and the selection of charge components are therefore based on this mode of production. Cost and economy must always be borne in mind in all phases of commercial manufacture, and these points have been given due consideration relative to other requirements.

Standard grades and mixings of iron suitable for special classes of castings are of little use unless the mixture charged, as distinct units, can be drawn off at the tap hole with their individuality maintained. Where circumstances permit the running of a cast with one grade of metal only, the problem is simple of solution. When the moulds to be cast for one day's work need different qualities of iron, charging and melting operations must follow a planned programme under close supervision.

A system giving good results in practice is worked as follows :—The cupolas employed hold six charges of 10 cwt. each, and the softest grade of iron is charged directly on to the coke bed, giving a double advantage. First, the softest grade, listed as No. 1 in Table II, is used to pour the less exacting castings, and secondly, a gradual blending towards harder iron can take place. Taking a definite case, suppose two ½-ton charges of grade 1 are placed first, followed by 10 cwt. of grade 2, which is a little harder. Two further charges of grades 3 or 4, cylinder iron, can follow, making a total of five. Table II gives another and harder grade, No. 5, which can be used with or without alloy additions. If this is needed, it follows after grades 3 and 4, making the furnace fully charged ready for blowing to commence. Other charges wanted to complete the cast are put on as required in reverse order, so that the grades work back again to softer metal.

In practice, the system resolves into taking the quantities of the various grades required to pour the moulds prepared, and charging in the manner described. A programme is made out with the exact order in which the different castings are to be poured, the weight of iron necessary and the size of ladle to be used. Then, when melting is in progress, no time is lost in making decisions of this nature ; confusion also is avoided. Time is a very important factor in gauging the grades as they come down. Unless the whole business is worked strictly to schedule it becomes a muddle.

The time-table is based on a constant melting rate, which is obtained through a standardised method of cupola operation. Regularity of charging and melting must go on without a hitch ; therefore reasonable uniformity in size of pig and scrap is important. Hanging up of the furnace distorts the timing and the charging of an extra coke split has a similar effect. Thus the practice of separating grades of metal by heavier coke charges is not satisfactory.

After melting is properly under way in the cupola previously mentioned, that is, after the first three charges, 10 cwt. of iron are melted every seven minutes. Having established a constant rate of melting and the placing of charges in an arranged order it is possible to tell exactly the stage reached at any point during the blow, the grade of metal which is melting and how much more may be expected. The presence of someone responsible for this timing is necessary throughout the duration of the melt. Likewise, too, the men who weigh out and load the charges must be trained and trustworthy.

By the practice of timing the melting of the charges and tapping at the end of completed periods the danger of splitting a charge, thereby getting a wrong mixture, is prevented. Only complete charge units should be tapped. Some of the work may require casting from small hand shanks. These ought not to be caught when the furnace is dry, as most irregular results come from so doing. One or more complete charges should be present in the receiver or well of the furnace.

Specified compositions for five pig irons and chemical analysis of foundry returns and bought scrap are included in Table I. Apart from ferro-alloys, these items are sufficient to provide the grades of iron shown by Table II, which gives as well an idea of their purpose and the minimum tensile and transverse strengths capable of being produced.

Total carbon content has a pronounced bearing on soundness. Pig irons of hyper-eutectic composition are not suitable for direct use in producing high-duty iron castings. Hematites are not favoured for this reason. It will be noted that all the materials listed in Table I have carbon equivalent values at or below the eutectic value of 4·3 per cent., excepting item B. Two of the pig irons, D and E, are of the refined type, and reserved for use in the highest-grade mixtures. Leaving out of account thick-sectioned work of 2in. and over, the most satisfactory total carbon content lies between 3·1 and 3·3 per cent. Values between these limits yield strong metal of close grain with reasonable machining qualities.

To keep within this range the carbon content of the charge materials must be restricted to under 3·5 per cent. for high-duty compositions, unless high percentages of steel scrap are included to dilute it. Steel scrap up to 10 or 15 per cent. of the total charge may be incorporated with advantage and no modification of the normal melting practice. Larger proportions require special precautions in melting, and when used with other pig and scrap for direct pouring into moulds troubles due to shrinkage and heterogeneity of the product are likely to be experienced.

Much has been done and published about the effect of total carbon content on cast irons, and its fundamental influence is widely recognised. As already stated, it must be controlled for high-duty castings. For work within the range of sectional thickness quoted the limits mentioned are satisfactory and can be maintained regularly without great difficulty or highly specialised cupola technique, providing T.C. is not present to excess in the materials charged. Charge materials having excess of coarse graphite tend to retain this characteristic even after passage through the cupola.

The charge coke is the greatest source of carbon entering the cupola, and to limit carbon pick-up it must be dense, of suitable quality and not charged greatly in excess of the quantity necessary to provide heat for melting and superheating the iron. Indeed, a study of the correct coke ratios for the bed and between the charges forms an essential factor in obtaining satisfactory high-duty castings.

Upon the quantity of coke to be burned depends the volume of the air blast. With uniform blast volume coke splits and metal charges, total carbon pick-up increases with height of coke bed. It also increases with increase of coke splits, blast volume and bed charge remaining constant. Blast volume should remain uniform throughout the blow. Raising the air volume tends to burn away the coke from the charges above the melting zone, with the result that the bed becomes lowered and metal charges melt too near the tuyeres.

Fast melting and removal of the iron from the coke bed minimises carbon pick-up. Receivers are advantageous from this point of view, and also because they allow of the tuyeres being placed nearer the base of the furnace, thus reducing the height of coke in the bed.

Although control of the total carbon ratio is a major factor in the manufacture of successful high-duty iron castings, it is not sufficient to consider it without taking into account the influence of silicon and phosphorus at the same time. The range of carbon given above applies where these two elements are restricted to within certain proportions. Pure iron-carbon alloys solidify at steadily decreasing temperatures until the eutectic composition is reached at 4·3 per cent. carbon. When silicon and phosphorus are introduced they have the effect of reducing the amount of carbon for the alloy of lowest melting point. It has been found that the reduction of carbon is 0·3 per cent. for each 1·0 per cent. of silicon, and 0·3 per cent. also for each 1·0 per cent. of phosphorus present. Consequently an iron with 1·0 per cent. each of silicon and phosphorus reaches the eutectic composition with 3·7 per cent. total carbon. Any carbon above this amount tends towards excessive graphitisation under normal conditions of cooling.

A convenient method of evaluating cast irons with respect to their eutectic condition has been suggested by the B.C.I.R.A. It consists in calculating the "carbon equivalent" value, which is the percentage of total carbon actually found to be present, plus the carbon equivalents of the silicon and phosphorus contents as mentioned. Thus, if the iron quoted above with 1·0 per cent. each of silicon and phosphorus had also 3·3 per cent. total carbon, its carbon equivalent value would be 3·3 plus 0·6, or 3·9 per cent. Incidentally, the author has found that as a general rule no composition of grey cast iron is likely to fulfil the definition for high-duty material unless the carbon equivalent value derived as explained is kept below 3·9 per cent.; a useful range is from 3·6 per cent.

Rejects resulting from shrinkage in one or other of its forms are a trouble particularly in evidence with castings of high-duty iron. It is an unfortunate fact that the higher-quality irons exhibit a greater tendency towards shrinkage during solidification because the expansion due to graphitisation is not so great as in high-carbon grey irons, and the liquid contraction is not counteracted to so great a degree. For this reason it is desirable to maintain total carbon ratios at as high a level as possible consistent with high-duty properties, and the metal practice outlined has been instituted with this point in mind.

Actually the amount of liquid shrinkage which must occur is not altered much by chemical composition. Casting temperature exerts the predominating effect, and high-duty irons need to be cast hot, since their range of fluidity is not so great as that of soft phosphoric irons.

Shrinkage defects have been classified under four headings :—(1) Piping ; (2) sinking ; (3) porosity ; and (4) cracking and warping. Although all are due to the inevitable volume changes which occur during the transition from the high-temperature liquid phase to the solid phase at atmospheric temperature, they are controlled to some extent by temperature of metal when poured, casting design, composition of metal and the mould conditions, particularly with respect to size and placing of runners and risers.

Piping is not very prevalent in grey iron castings unless they are very massive indeed. Sinking is more often found and may be regarded as incipient piping. Porosity is the main anxiety with pressure-resisting castings, oftentimes not revealed until the hydraulic test is applied.

Phosphorus and its effect on porosity have provided a basis for much discussion. There is no doubt that substantial percentages increase the range over which solidification takes place. For pressure-resisting castings of complicated design with ribs, bosses and abrupt changes of section, it is better to restrict it to around 0·3 per cent. Such castings have many places where feeding is impossible to apply. Thick sections naturally cool slowly with predisposition to formation of coarse grain and porosity. Therefore it is logical to avoid a composition which will allow these places to contain liquid metal longer than is necessary.

Some authorities think that the *rôle* played by phosphorus in causing porosity is over-emphasised. They invariably quote instances of castings containing appreciable amounts of it which have not shown any trace of porosity and have, moreover, functioned perfectly in service. Whilst it is not possible to refute such evidence, at the same time the instances brought forward, upon examination, often turn out to be of a type or design such as would not be highly susceptible to the defect which high phosphorus content helps to cause. Certain types of casting do benefit from the presence of phosphorus, but the high-duty casting for pressure resistance is certainly not one of them.

Work carried out by the B.C.I.R.A. confirms that the type of shrinkage defect depends on the proportions of silicon, carbon and phosphorus in the metal. An increase in one or all of these elements assists in bringing about porosity and by correct regulation the tendency may be considerably lessened. The conclusions reached were that, with silicon at 1·5 per cent. and phosphorus greater than 0·25 per cent., total carbon must not exceed about 3·4 per cent. Similarly, with 2·0 per cent. silicon, the limit for total carbon is at 3·2 per cent., and for 3·0 per cent. silicon at around 2·7 per cent. Silicon and phosphorus are easier to control with cupola melting than is total carbon, so that metal analyses should be adjusted along these lines.

A study of Table I will reveal the fact that all the pig irons contain manganese in amounts beyond the average. The idea is to arrange the charges so that a manganese content of between 0·75 and 1·0 per cent. is present in the castings. From experience gathered during twenty years the author is convinced of the benefits to be derived from manganese up to this amount, particularly for castings of the high-duty type.

Briefly, manganese assists towards the production of sound castings by combining with the sulphur. To ensure an absence of iron sulphide an excess of manganese beyond the theoretical quantity for chemical combination with the sulphur is needed. Norbury has suggested a minimum ratio of 1·7 times the sulphur content plus 0·3 per cent., which works out at 0·47 per cent. manganese for a sulphur content of 0·1 per cent. By adopting this practice the iron is less likely to form hard or chilled edges. A surplus of manganese above that required by Norbury's formula is advisable as melting losses may reach 30 per cent. Apart from this, manganese helps to increase fluidity, shortens the freezing range and gives a closer-grained iron, so that the more manganese there is present—at any rate up to 1·0 per cent.—the less tendency exists for shrinkage to occur as draw-holes.

Additions to cast iron of elements such as copper, nickel, chromium and molybdenum have done much to widen its field of usefulness by imparting new properties. For most applications, ruling out the highly alloyed special cast irons, the combined or total alloy additions are not required in excess of 2 or 3 per cent., quantities which allow of introduction directly to the molten iron in the ladle. Special combinations of the alloy metals are available, so arranged that an exothermic reaction results and no temperature drop is caused.

The five grades of cast iron set out in Table II are of themselves enough for many and varied casting requirements. Suitable ladle additions to either grade 4 or 5 will extend the range considerably and include castings for internal combustion engines, diesel engine liners, brake drums, heat-treatable cast iron and iron for chilled castings.

Several advantages accrue from the addition of alloys direct to the melt in the ladle as opposed to their incorporation as such in the cupola charge. Chromium is subject to a substantial loss in passage through the furnace and forms a very refractory slag. Moreover, accurate determination of the amount to be used for a definite percentage in the casting is difficult as the degree of oxidation varies.

Nickel is not subject to oxidation and loss in the furnace like chromium, but here again ladle additions are more exact, confining the alloy to a given volume of metal. Much more latitude in working is possible, as charges can be alloyed differently from one to another, as the castings to be poured may require, without any alteration to the basis charges entering the furnace.

To summarise, ladle additions are more precise, suffer the minimum wastage of alloying elements, ensure that the alloys are just where required, and, providing proper precautions are taken in making the additions, no troubles from lack of solubility or homogeneous mixing arise.

Pressure-tightness and good wearing qualities are main characteristics striven for in the castings

described here. For these properties nickel alone or in combination with copper suffices to render thick sections dense and sound and maintain thin sections grey and machinable. Alloying is accordingly restricted to the use of these two metals in the majority of cases.

A point which will stand emphasis is that for receiving alloy additions a good base iron is desirable. Ferro-alloys are expensive materials, and they should be utilised to the maximum advantage. It is possible to load up an ordinary soft iron with alloys until it meets the high-duty specification, but this is an uneconomical use of alloys. They should be reserved for use with a good base iron and not in an attempt to make a poor iron into a fair one. Another factor to remember is the need for adjusting the composition of the base iron to suit the additions being made. Most of the elements used for alloying have a plus or minus silicon equivalent which must be allowed for in order to get optimum results.

Iron returned from the foundry for remelting is kept to its separate grades, as indicated in Table I. By so doing, alloy-bearing scrap is available for re-use in similar mixtures and the new additions needed subsequently will be less in proportion to the quantity already there. Care over this matter ensures that alloyed material does not contaminate mixtures where it is not wanted, although nickel and copper in small amounts cannot do harm to any composition.

Table II shows that " foreign " or bought cast iron scrap F is employed in the two lowest grades 1 and 2 only. Its chemical analysis is not known definitely ; thus it should not be employed in charges for high-duty castings. Runners, risers, &c., from grades 1 and 2 are collected and stored separately to form item G of Table I. Likewise, returns from grades 3, 4 and 5 are gathered together under H. The remaining classification J represents the alloyed returns previously mentioned. Segregation of the scrap returns in this way helps considerably in maintaining that regularity of product stressed above. It also contributes in no small degree towards soundness. Another valuable attribute of the grading and separation of returns exists in the knowledge of its chemical constitution. Regular check analyses on the grades melted ensure this, making it a constituent of known effect, and in this respect equal to pig iron. Allocation of the proportion of foundry returns used in the charges is such that a balance is struck between production and consumption, ensuring neither excessive accumulation nor shortage.

Metal Parts Cleaning

THE two machines illustrated in the accompanying engravings have recently been produced by Dawson Brothers, Ltd. They were designed in conjunction with the technical staffs of the firms in whose works they are installed. The purpose of the machine illustrated in Fig. 1 is to wash engines taken from crashed aeroplanes before they are dismantled prior to reassembly. The same machine can also wash quantities of component parts if necessary. It is being supplied to Rolls-Royce, Ltd. This machine is 33ft. 6in. long, 10ft. 6in. wide, and 12ft. 6in. high, and its approximate loaded weight is 30 tons. The engine or component parts are placed in large swing carriers which are swung on two heavy mild steel roller chains. The conveyor runs very slowly. It is driven by a 2 H.P. motor, through a 14,400 to 1 reduction gear unit. As the engines or parts travel through the machine they receive first a 30-min. soaking period at 180 deg. Fah. in a solution made up to a special formula. From this stage they pass over the top of the soaking chamber to the second operation, which is a 6-min. high-pressure clean-water wash, also at 180 deg. Fah. The centrifugal pump is driven by a 15 H.P. motor, giving a pressure of 22 lb. per square inch at the actual jets, which are numerous and situated all round the carrier in order that no crevice in the engine or part is missed. The header is fitted with an air connection to couple up to the main supply in order to boost the pressure even further. The carriers then pass out of the washing chamber, and are subject to a 2-min. air blast to blow off the moisture on the parts. The engine or parts then travel back to the loading end of the machine. The machine is steam heated, and the temperatures are thermostatically controlled.

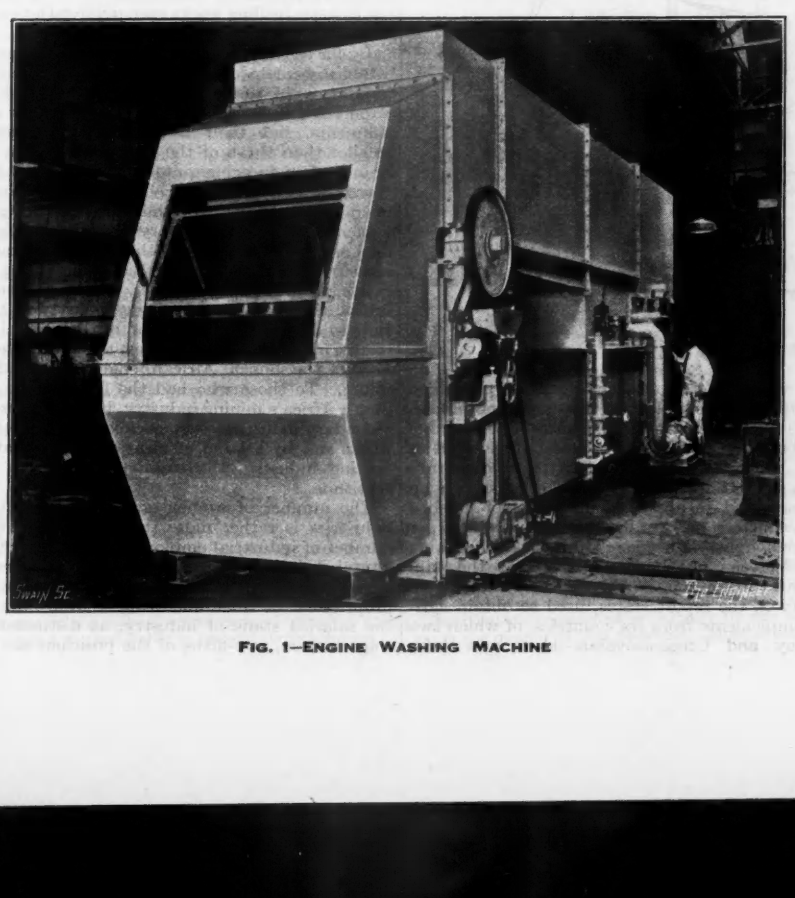


FIG. 1—ENGINE WASHING MACHINE

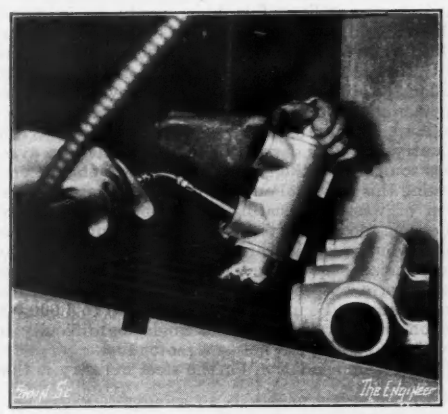


FIG. 3—FINAL HAND WASH

The other machine, Fig. 2, is intended for very intricate cleaning of carburetter parts for aircraft, and has a special sight chamber for final intricate high-pressure cleaning by hand. This machine was produced under Air Ministry authority for Standard Aero, Ltd. The carburetter parts are placed in wire baskets and passed into the washing chamber, where they are subjected to a powerful solution wash operated from numerous jets fixed at each side and top and bottom of the chamber. In this chamber there is a revolving platform or table, which slowly turns the baskets of parts to allow for thorough cleaning of all crevices, tapping holes, &c. The wash water in this chamber is constantly filtered. From this wash the parts pass into the special sight chamber where an operator using rubber gloves through two " port-holes " takes each part, and with a high-pressure hand-grip operated nozzle, fixed to a branch from the solution wash pump, cleans every crevice and hole individually, as shown in Fig. 3. He watches the work through a glass panel conveniently fixed as shown in the illustration. The interior of this chamber is illuminated by a light in the top of the cover.

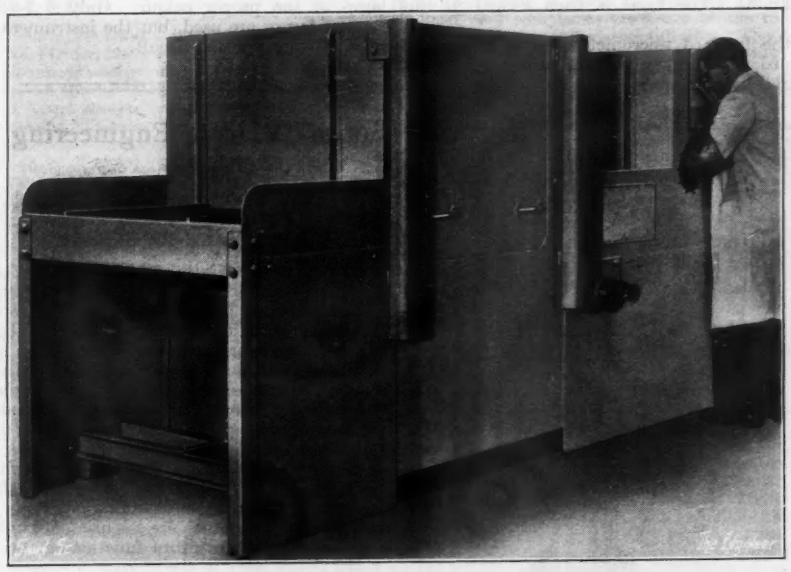
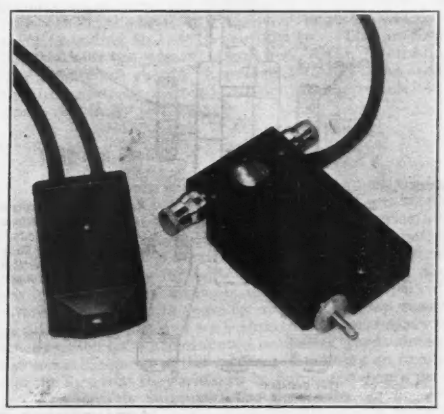


FIG. 2—MACHINE FOR CLEANING CARBURETTER PARTS

An Electric Gauge

THE electric gauge shown in the accompanying illustrations is used for the rapid inspection of parts and is made by the Sheffield Gauge Corporation, of Dayton, Ohio, U.S.A. Its capacity is 6in. With or without the light unit, shown separately in one of the illustrations, it may also be used instead of an indicator on special fixtures for machine tool control, &c. A red light indicates that a part is undersized, a green light that it is oversized, and a yellow or amber light that it is within the specified tolerance. A micrometer fine adjustment facilitates quick setting up, the overall adjustment being ¼in. The gauging point is easily removed and renewed.

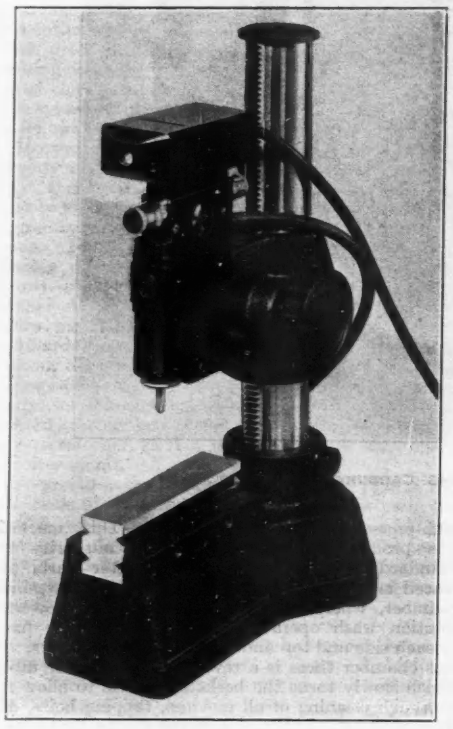


LIGHT UNIT

When the gauge is set up for any specified tolerance any piece of work that corresponds exactly to the limit of this tolerance, or which falls anywhere between the limits, is considered passable. There are two precision blocks, one corresponding to the

maximum tolerance and the other to the minimum tolerance. When the former is placed on the anvil under the gauging point, the gauging head is lowered by means of a hand wheel until the gauging element contacts with the precision block and the contact arm as seen through the window on the right side of the gauging head moves to a position between contact knobs. The head is then locked in this position.

With the forward micrometer screw adjustment the forward contact knob is adjusted so that the amber light just switches on as the gauge block is



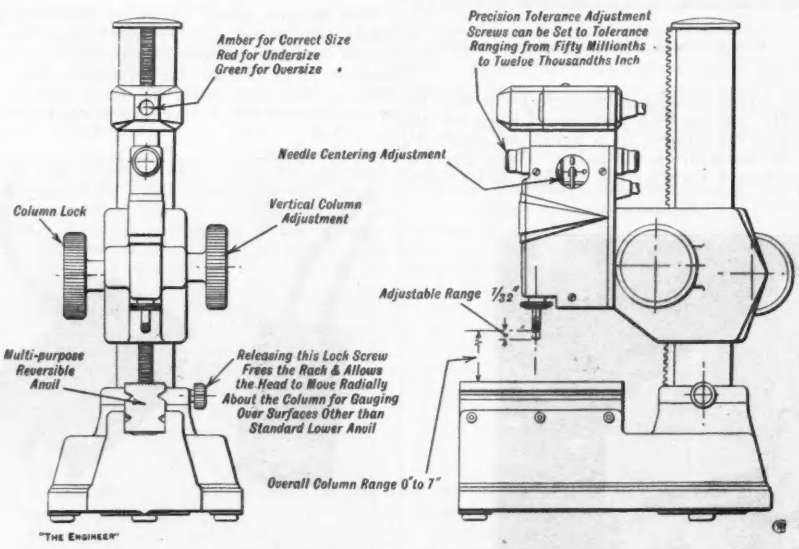
ELECTRIC GAUGE

moved under the gauging element. This procedure is then repeated using the minimum tolerance precision block, and adjusting the rear micrometer screw until the amber light just switches on, when the gauge block is passed under the gauging element. The amber light will therefore only indicate acceptable pieces—that is, those that come within the tolerance limits, both tolerance limits included. Otherwise the red or green light will show as indicated in the drawing.

The micrometer screws at the front and rear are graduated. Each graduation is approximately ¼in. long, and is equivalent to 0·0001in. movement of the gauging element. Hence the movement of either micrometer screw one numbered division will raise or lower the tolerance 0·0001in. Interpolation can be made for changes of one-quarter of this amount with accuracy.

As the gauging point is obviously subject to wear, after a sufficiently large number of work pieces have been gauged without a change of setting of the instrument, it is desirable to check the gauging point for wear, and any wear that is discovered is compensated by the gauging element screw. When thus handled it is unnecessary to make any change in either of the micrometer screws.

The forward end of the light unit consists of a cap which snaps in place and is held by two long retaining screws which enter from the rear of the unit. To replace a burnt-out lamp the current is turned off, the two retaining screws are removed, and the forward cap is pulled off. When this cap is removed the burnt-out lamp is replaced by another lamp of the proper colour. Only 6·5-volt, 2·75-ampere lamps are used, but the instrument operates on a 110-volt lighting circuit.


Amber for Correct Size
Red for Undersize
Green for Oversize
Precision Tolerance Adjustment Screws can be Set to Tolerance Ranging from Fifty Millionths to Twelve Thousandths Inch
Needle Centering Adjustment
Column Lock
Vertical Column Adjustment
Adjustable Range 1/32"
Multi-purpose Reversible Anvil
Releasing this Lock Screw Frees the Rack & Allows the Head to Move Radially About the Column for Gauging Over Surfaces Other than Standard Lower Anvil
Overall Column Range 0" to 7"
"THE ENGINEER"

ARRANGEMENT OF ELECTRIC GAUGE

South African Engineering Notes

(*By our South African Correspondent*)

CAPE TOWN, July 9th, 1940.

Union's Industrial Requirements

THE first interim report of the Commission on Industrial and Agricultural Requirements in the Union has just been published. The report deals with the effect of the war up to the eve of the invasion of the Low Countries on important Union industries, including the steel, coal, fertiliser, explosives and timber industries, as well as the country's requirements of agricultural implements and wooden boxes. Broadly speaking, the Commission's task is to map out a practical line of action to serve as a guide for the newly established Industrial Development Corporation. This is a very wide subject and the present report is confined to an examination of the supply of certain materials which are essential, not only to keep industries and agriculture functioning, but to safeguard the country in the present emergency.

From the point of view of the active prosecution of the war, the two most important essentials with which the report deals are fuel and steel. In regard to the former the Commission asks that all necessary steps be taken to establish and maintain stocks of all imported oils. A long-range policy for the local production of liquid fuels might be investigated. Investigations should be accelerated into the alterations which might be made to the common types of motor-car engines to enable them to run on producer gas; into the possibility of building producers in South Africa; and into the resources of subsidiary fuels which could be made available for portable producers in this country. It is estimated that about 5,000,000 gallons of lubricating oil are used every year in cars and aeroplanes in the Union, most of which, after use, is allowed to run to waste, which is deprecated, as this country is wholly dependent for its supplies on overseas sources and there are methods available of processing this waste oil and the collection and regeneration of waste lubricating oil is one of the urgent questions needing attention. The Commission does not favour erecting plants to produce power alcohol from maize, sugar or grapes, but suggests the use of molasses, a by-product of sugar. In this way production might be increased by 3,000,000 to 4,000,000 gallons a year, though there might be difficulty in selling the power alcohol as a motor fuel.

The recommendation for the steel industry is that work on the new steel making plant be proceeded with as rapidly as possible, and that means of increasing coke supplies be investigated immediately with a view to building up as large a stock of pig iron as possible. When the Duplex plant at Iscor comes into operation in 1941 the total production of the Union will be increased to about 420,000 tons of finished products, which on pre-war figures is just about 40 per cent. of the country's needs. The new steel making plant (at Vereeniging), however, will bring the total up to about 730,000 tons.

The Union, the report states, used to obtain agricultural implements from six countries, of which two—Germany and Czechoslovakia—have now been cut off. Prices have increased considerably, but a factory at Vereeniging for large-scale manufacture should start producing in October. The manufacture of spares will be started earlier.

Dock Accommodation Tested

When the Railways and Harbours Administration embarked upon their programme of increased dock accommodation for the growing fleet of merchant ships trading with the Union of South Africa it was confidently asserted that at a cost of some eight millions or so dock accommodation would be provided for all demands which would arise in the following thirty years or more. But this calculation left out of consideration the possibility that war might cause the diversion of a great part of the vessels making use of the Suez-Mediterranean route to the Cape of Good Hope route. As a result of this diversion not only have all the berths under the Table Bay programme had to be commissioned—several before their complete equipment—but in addition to the eight berths so provided ships have had to make shift by lying alongside the east mole, forming the seaward side of the New Basin, both on the outside and inside, and if the diversion of shipping to the Cape route is to be permanent it will be necessary to extend the quay and wharfage running along the front of the city of Cape Town and on towards Woodstock, so as to provide the three further large berths for which space is available. This work is now recognised as urgent and the demand for proceeding with the big 1200ft. graving dock, which forms part of the plan for increased shipping accommodation, is also growing and will no doubt be proceeded with ere long.

While the demand for more ship berths is greater in respect of the Cape Town docks—this port is the great oil fuelling port of South Africa—the cry for berthage is also loud in respect of the Durban port. Here, however, the additional deep-water berths under the Government's £2,212,384 scheme should suffice. At Port Elizabeth harbour the new tanker berths to provide bulk oil facilities are complete and at East London the extensions to the turning basin, mail boat quay, sheds, &c., are making satisfactory progress. When all these works have been completed the Government will be able to claim that it has made such extensions to its provision of shipping accommodation at the harbours of the Union as should prove adequate for a number of years.

Union Engineering Industry

At a time when plans are being considered for mobilising South Africa's resources it is in the direction of the metal and engineering industries that consideration is extended. The important questions are what they can manufacture and whether they are sufficiently developed to supply all the country's requirements. The following are some facts bearing on the matter.

Engineering works and foundries account for the largest number of establishments in the metal industries. There are more than 300 of them with a fixed capital of more than £6,000,000. The second largest group is made up of the 289 galvanised iron and plumbing works, but these are, on the average, comparatively small establishments. Then there are 127 mine workshops and 200 electrical apparatus and electrical engineering shops; but many of these, again, are very small in size. Some of the sections of the metal and engineering industries which contain only a few establishments are none the less very important. Wire works, in the last available industrial census, were only five in number, but their average capital employed was in excess of £50,000 per establishment. The brass and copper works averaged about £10,000 fixed capital per establishment, and the five steel ceiling works each involved an equivalent investment of fixed capital.

By far the larger number of the Union's engineering establishments are situated on the Rand and a large proportion of their output goes to the gold mines. Cape Town also accounts for a large number of establishments, but their average size is considerably smaller than those of the Transvaal. They cover a branch of engineering quite different from that on the Rand and they include among their more important operations marine repair and construction work. The Durban engineering industry also undertakes a great deal of this work. To-day the metal and engineering industries are playing a rapidly increasing part in South Africa's economic life. Taxed to the utmost limits, the British engineering industry is hard put to it to deliver even a fraction of the normal requirements of the Union for peace-time purposes. This breach the South African engineering industry is filling. To those who had the foresight to see that South Africa's mining industry, its agriculture and its secondary industries were backed up by iron and steel works and by a large, efficient and many-sided engineering industry, the country is under a debt of gratitude.

The number of women engaged in South African industries is rather more than a tenth of the total number of industrial employees—about 36,000 out of a total of slightly more than 300,000 workers of both sexes. Among them are 278 women who are working proprietors of manufacturing establishments. In the salaried staffs of industry, as distinct from the wage-earners, two-fifths of the positions are held by

women. Of the wage-earners in industry, women represent nearly 12 per cent. They number about 32,000 out of a total of both sexes of 275,000 odd. Those industries which gave the greatest employment to European women during the last war, still do so, but the increase therein is not large. In fact, looking back on the part played by European women in South Africa during the last quarter of a century, they do not appear to have extended the field of their activities very much.

Looking at the experience of the last war, one finds that there were no startling increases in the employment of women as compared with pre-war figures. But in the last war South Africa's industrial development was insignificant and the country was so much more dependent on overseas imports that it would be unwise to draw conclusions from the experience of those years. In South Africa, no less than in England, opportunities for increased employment are growing day by day. It must not be forgotten, however, that the industries and occupations suitable for the employment of women are not as plentiful here as in England. While women are no doubt destined to play a great part in developing the resources of South Africa during the war, it is probable that their opportunities will be considerably more restricted than those of women in Britain and the other Dominions.

Shaft Sinking Record

By sinking 454ft. during May a new world's record for sinking a six-compartment shaft has been established at the new deep shaft on the West Rand Consolidated mine, Krugersdorp. During the thirty days of April the shaft was sunk 441ft., which beat the record for a six-compartment shaft held by the Vlakfontein mine since 1936. During May 457ft. were timbered and the shaft reached a depth of 1567ft. It is intended to sink it to 5502ft.

Sixty Years Ago

A SUMMER MEETING OF 1880

THE summer meeting of the Institution of Mechanical Engineers in 1880 was held at Barrow-in-Furness. It was much more of a technical occasion than those of modern times. Mr. E. A. Cowper was the President and opened the meeting with an inaugural address, in which he devoted attention to the general depression in trade which had prevailed for a number of years and to the means within our power of promoting the manufacture and commerce of the country. The President of the Iron and Steel Institute, Mr. Williams, moved a vote of thanks to Mr. Cowper. He expressed his disagreement with Mr. Cowper's implication that England was lagging lamentably behind other nations in industrial enterprise. A paper by Mr. Stileman on "The Docks and Railway Approaches at Barrow-in-Furness" was then read and thereafter Mr. Humphreys presented a paper on the steamship "City of Rome," an Inman liner then on the stocks at Barrow. Following a mayoral luncheon, the members visited the Barrow Shipbuilding Company's yard to inspect the "City of Rome." The day was completed by a trip to Lakeside. On the following morning Mr. Shaw read a paper on "The Hematite Iron Mines of the Barrow District," Mr. Fleming one on "Jute Manufacture," and Mr. Davis one on "The Steel Compressing Arrangements at the Barrow Hematite Steel Works." In the afternoon visits to the local jute and steel works were made, and in the evening a dinner was held at the Market Hall, "when a large number of toasts were proposed," as our report of the proceedings expressed it. On the morning of the third day Mr. David Joy read a paper on his "New Reversing and Expansion Valve Gear," then recently adopted by Mr. Webb on some L.N.W.R. goods engines. Monsieur George Marie, of Paris, next presented a paper on "A Standard Gauge for High Pressures." The members by this time had apparently had enough of papers and before the only speaker to take part in the discussion on Monsieur Marie's paper had completed his remarks the meeting hall began quickly to empty. The afternoon was devoted to visits to a number of ironworks and mines in the neighbourhood, the members subsequently re-uniting for dinner in a large marquee on the shores of Lake Coniston. After dinner a trip on the lake was taken on a "steam gondola," a remarkable flat-bottomed craft, nearly 100ft. long with accommodation for 223 passengers, which had been in service on the lake for twenty-one years. Her machinery, we recorded, included a boiler with a crucible steel fire-box, and was "kept in excellent order by a very intelligent engineer." The meeting concluded on the following day, Friday, with a pleasure excursion to Windermere.

MOTOR LIFEBOATS ON MERCHANT SHIPS.—In reply to a question in Parliament with reference to the provision of motor lifeboats on all existing merchant vessels, the Minister of Shipping, Mr. Cross, stated that the course proposed would involve not only the provision of a large number of motors, but also extensive alteration to the lowering gear on the ships themselves, and therefore such provision was not practicable in present circumstances.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Tin-plate Supplies

Great interest was aroused by the control of tins and cans (No. 1 Order, 1940), which took effect on July 23rd. By this instrument restrictions are imposed upon the use of tin-plate, tin sheets, black plate, silver-finished plate, terne plate, terne sheets, wrought copper sheets, black copper sheets and galvanised sheets for the manufacture of metal containers having two-thirds of their external surface area made on or of metal. Such containers may not be used for packing many kinds of foodstuffs and other commodities and for certain uses laid down in the Order. For other materials such as paints, varnishes, enamels, oils, paraffin and cleaning materials, certain sizes of tins are approved. The effect of this limitation of the uses to which tin-plate, &c., may be put is not quite clear at the present time, but it should considerably reduce the consumption. At present the tin-plate works are operating at about 65 per cent. of capacity, but the trade of late has been quiet and reserve orders on manufacturers' books have dropped from over 10,000,000 basis boxes to just over 6,000,000. The iron and steel distribution control scheme, after a transition period, is now to be applied to the tin-plate industry, and this system aims at obtaining organised deliveries and distributing fairly the quantity of steel available for distribution in the form of tin-plate, &c. A number of engineering firms are affected who, before the war, were not regular users of tin-plates in their business. Many of these firms have been brought into the war effort and for some time were amongst those who suffered most severely from the congestion of orders at the tin-plate works, and it was to relieve this state of affairs, which applied to most branches of the steel trade, that the distribution scheme was brought into operation in April. Many of these engineering firms use only small quantities of tin-plates, but theirs is largely essential work, and it was found that only by adopting the allocation system were they able to obtain their requirements from the tin-plate works, who were severely pressed by other consumers. It is believed that when the scheme is fully in operation that many of the difficulties these firms have suffered from will be removed.

Steel for Buildings

The Iron and Steel Control of the Ministry of Supply has issued the following: Control of Iron and Steel (No. 8) Order, 1940, Control of Iron and Steel (No. 11) Order, 1940. Direction (No. 1) to the No. 8 Order, Paragraph 5 (*b*), allows any material mentioned in the First Schedule to be acquired without licence from the stock actually held at the time of purchase by a stockholding merchant, but only in the form in which it is in stock. The No. 11 Order prevents the treatment, use or consumption of material for building. Article 3 of that Order, however, allows acquisition of material for a building from a stockholding merchant under Paragraph 5 (*b*) of the No. 8 Order in quantities not exceeding 1 ton in any period of one calendar month, but still only in the form in which it is in stock at the time of purchase. It is necessary that suppliers and customers should appreciate immediately that there is a distinction between (1) an authority to acquire material, and (2) an authority to treat, use or consume material. In the case of the exemption of orders of not exceeding 1 ton of material for one specific building, suppliers and consumers should bring this within the Order by (i) selling and acquiring the material in the form in which it is in stock, and (ii) obtaining and giving orders (within the exempted quantity of 1 ton) for the fabrication of that material. Suppliers should obtain a certificate from the purchaser that the total steel acquired for the specific building by the purchaser during that calendar month up to the date of purchase (including the material then purchased) does not exceed 1 ton. Stockholders and others under the No. 11 Order must ascertain in supplying more than 1 ton of material, if they are asked to fabricate it, whether it is for treatment, use or consumption in a building before they can carry out any order for fabrication. At the moment, in accordance with the No. 11 Order, only the treatment, use or consumption of steel for building is prohibited, but it is intended in an early Order to take power to prevent the unnecessary use of steel for certain unessential purposes other than buildings. Suppliers and consumers are warned, therefore, that steps will be taken to stop the treatment, use and consumption of steel for unessential purposes, and they are asked to co-operate with this Control to that end. It has always been the desire of the Control to avoid unnecessary restriction on the iron and steel industry, and in fact to avoid the necessity of general licensing of the use of steel, whether by stockholders, composite firms or in any other direction, but experience has disclosed a lack of co-operation in certain quarters in stopping the use of steel for unessential purposes which has necessitated reconsideration of this whole question.

The Pig Iron Market

The demand for pig iron is steadily broadening, as fresh firms are being brought into the war effort. The demand continues to be chiefly for basic pig iron, upon the production of which the producers are concentrating, and as they are working under the direction of the Iron and Steel Control, they have to manufacture the kind of iron which is chiefly required in the national interest. Whilst the position at times becomes tight, the careful supervision of distribution, the expansion of production, and the help afforded by imports from abroad, has resulted in a steady flow of raw material to the steel works. In the foundry section of the market the situation seems to be rather irregular. Recently more light castings makers have been brought into the war effort, and as a result there is a better demand for high phosphoric pig. Consumers' difficulties are occasioned principally by the necessity of using the quality of iron provided. Most consumers have had to alter the mixtures to which they have been accustomed, and complaints are heard of the inconvenience caused by this unavoidable difficulty. The demand for low phosphoric iron is steadily strengthening, and some tightness is noticeable. It has been possible, however, to keep supplies moving satisfactorily, and it is expected that the output of this quality will be increased. The situation in the hematite market has become rather stringent. The demand is definitely in excess of production, and for some time past consuming works have had no reserves to fall back upon.

The Midlands and South Wales

The race between production and demand continues, but the latter remains some distance ahead. Not only have consumers' requirements expanded, but their wants have broadened to cover practically all descriptions of iron and steel. There is now a much greater use of finished iron and almost all the plants in the Midlands are working to capacity. To some extent this demand has arisen because a few weeks ago iron makers were able to give earlier delivery than could be obtained from any steel works. Since the question of price does not enter into material required for urgent Government work, this demand has grown, and now there is great pressure to obtain supplies of high-grade iron and some of the cheaper qualities. The call is particularly insistent from chain makers and railway wagon builders. The situation as far as steel is concerned has not materially changed. All the heavy steel works are fully employed, and whilst the production of joists and sections was never greater, there is no diminution in the wants of the structural engineers who are busily employed upon Government building schemes all over the country. The pressure to obtain supplies of shipbuilding steel is maintained, and some stringency prevails in the plate department. The expansion is particularly evident in the case of aircraft, and special steels which are passing into consumption in considerable quantities. In South Wales the steel works continue to operate at capacity. The demand from the constructional engineering trades is particularly heavy, although this has been a feature of the market for many months. The local production of steel is pressed to the utmost, but the quantities of sheet and tin-plate bars allocated to the tin-plate works imposed a certain limit upon output. Within the last few days there has been an improvement in the overseas inquiry for tin-plates, and the home trade also is calling for larger quantities.

Copper and Tin

The situation in the copper market has not materially changed. In Great Britain the supplies are adequate to meet the wants of the consumers engaged upon war work, although the total tonnage moving into consumption reaches a huge total. The authorities are now turning their attention to a greater use of scrap metal, of which it is understood that large stocks are held in this country. The use of this material should not only result in the saving of shipping space, but should relieve the scrap dealers of stocks which were rapidly becoming inconvenient. In the United States the domestic inquiry has fluctuated somewhat, and as a result prices vary, the quotation ranging between 11·12½ c. and 11·50 c. The weakness which characterised the market last week appears to have passed, but the undertone of the market shows no real firmness. There has been very little export business but there has been some inquiry from Japan.... The tin market has been somewhat irregular. In the middle of last week prices advanced on a fair inquiry from America, but later when this subsided values showed a tendency to fluctuate. The impression in the market is that prices are unlikely to advance to any considerable degree, but that they will remain round about 50 c. per lb., the price at which the United States Government is willing to buy the surplus tin. The production of tin under the present regulation of the International Tin Committee should be sufficient to meet the world's requirements, since many tin-consuming countries are now overrun by Germany.

Lead and Spelter

Conditions in the lead market are much the same as those which have prevailed for several weeks past. Although the Control carefully supervises deliveries, a fair amount of metal is available for uses other than national work. There is a good demand for lead from the cable makers, as well as for batteries, and certain lead alloys are in request from firms engaged upon war work. The intention of the authorities to utilise the scrap reserves of this country has met with approval. The considerable stocks which have accumulated in dealers' yards since the the commencement of the war were becoming an incubus, and the fact that they will now be liquidated over a period has considerably improved the prospects of the scrap trade. Supplies of lead are readily obtainable from the Control for those firms which are engaged in making exportable products, and this indicates that the situation, so far as supplies are concerned, is regarded as satisfactory.... The spelter situation is sound, but there is not so much metal available for consumers who are not engaged upon war contracts and users who want spelter for manufacturing exportable products frequently have a difficulty in obtaining licences. The galvanisers continue to absorb large quantities, whilst the die-making industry is also working full time and taking up good tonnages. The brass makers also are operating at capacity. Supplies of spelter to this country from Empire countries are sufficient to meet all requirements, although some firms accustomed to use G.O.B. brands complain that they are obliged to use high grade in the majority of cases.

Notes and Memoranda

Rail and Road

RAILWAY CHARGES.—The Minister of Transport has made an Order authorising the minor railways subject to Government control to increase their charges by 10 per cent.

NEW VEHICLE REGISTRATIONS FOR JUNE.—Returns issued of new vehicles registered for the first time by all registration authorities in Great Britain during June, 1940, show that there were 1891 cars taxed on horsepower, compared with 26,502 in June, 1939, and 1248 goods vehicles, compared with 5177 in June, 1939. Figures for all classes of mechanically propelled vehicles, including hackney carriages, electric vehicles, tractors and motor cycles, are 8399 for June, 1940, compared with 40,844 for June, 1939.

CANADIAN MOTOR FACTORY EXTENSION.—Work is to start immediately, it is reported, on an extension to cost 700,000 dollars to the Windsor factory of the Canadian Ford Company, to increase facilities for the production of military equipment. The extension will consist of an addition to the 15-acre machine shop in order to provide 109,440 square feet of new floor space. The new shops will be of modern construction, with a steel frame and reinforced concrete and steel sash walls and a wood block floor. Extensive ventilation systems are planned.

L.M.S.R. DIRECTORATE.—The directors of the London Midland and Scottish Railway announce that Viscount Runciman has rejoined the board. It will be remembered that Lord Runciman relinquished this position last year to take up Government duties. The directors also announce that Sir Robert Greig, a director and a member of the Scottish Committee, has been appointed Chairman of the Scottish Committee in succession to the late Mr. Charles Ker. Sir Ian Bolton, a partner in Messrs. McClelland, Ker and Co., chartered accountants, of Glasgow, and a member of the Scottish Committee, L.M.S.R., has been appointed a director.

NIAGARA FALLS ROAD BRIDGE.—Work has started on the foundations, both on the American and Canadian sides of the Gorge, of a new Rainbow bridge over the Niagara River, to replace the Falls View bridge destroyed by an ice jam in 1938. The new bridge is estimated to cost four million dollars and will have a main arch span of 950ft. It will be the longest bridge of its type in America, the next longest being the Hendrick Hudson bridge across the Harlem River at New York City. The bridge will have no superstructure other than railings, thus affording an unobstructed view of the rapids and the two falls. Traffic will be carried by two 22ft. roadways, separated by a mall. Foundations for the new structure, in the face of the Gorge cliffs, will be above the level of any possible ice jam, so as to eliminate the possibility of any such happening as destroyed the Falls View bridge.

MOTOR VEHICLE DRIVING LICENCES.—Under an Order made by the Minister of Transport, any person over the age of twenty-one holding either an ordinary driving licence, whether full or provisional, authorising him to drive vehicles in Group 1, or a national service driving licence authorising him to drive vehicles of all descriptions, may drive a heavy goods vehicle without further licence or permit. The holder of a heavy goods vehicle driver's licence or permit should therefore not apply for its renewal when it expires. The Order also extends for another year the validity of every public service vehicle driver's and conductor's licence and permit still in force. It is therefore not necessary to apply for a renewal for another year from the date of expiry. In addition, the period of validity of all public service vehicle drivers' and conductors' permits issued in future is extended to two years.

POST OFFICE UNDERGROUND RAILWAY.—An article in the *Electrician* describes a driverless electric train similar in type to that used by the British General Post Office, but of later construction, employed by the Postal and Telegraph Authorities at Zurich. Although the tunnel for the railway was built eleven years ago, it is only recently that the authorities have completed the construction of the railway and its stations. The railway runs through a tunnel 1133 yards long, extending from the Sihl post office to the basement of the branch post office at the railway station, where it terminates in a lift. This lift raises the motor truck right into the post office. At present the railway has only one track, with a siding at each end of the line, and under normal working conditions a driverless electric truck runs to and fro between the end stations. The truck is set in motion by pressing a push button on the main control panel; the truck travels the length of the tunnel and reaches the lift in the basement of the railway station. There the lift comes into action automatically and raises the truck into the post office. The order for the whole installation was placed with the Ateliers de Construction Oerlikon.

Air and Water

AMERICAN AVIATION PETROL EXPORTS BAN.—The United States Government has banned the export of aviation petrol to all nations except those of the Western Hemisphere.

WELDED STEEL COAL BARGES.—Arrangements have been made by the Dravo Shipbuilding Corporation, of Pittsburg, to build steel coal barges by mass production methods. According to the builders, the first few vessels completed led to orders for some twenty vessels of the same type and it was decided to standardise production. The barge has a width of 26ft., a depth of 10ft. 8in. and a length of 175ft. overall, with a carrying capacity of about 1000 tons. It is constructed of standard rolled steel shapes and plates cut to size and welded together. Welding is carried out by the "Shield Arc" process with equipment of the Lincoln Electric Company's manufacture. At the fabrication shop of the Dravo shipyard the parts are tacked together and assembled on a rolling production line, at the end of which the barges are dropped into the river broad- side on.

BOMBERS TO FLY THE ATLANTIC.—American bombers will, it is believed, soon be flown across the Atlantic to Britain. The bombers will take off from Canada and the flights will be supervised by Captain A. S. Wilcockson, the Imperial Airways pilot, whose services have been lent to the Ministry of Aircraft Production.

GERMAN AND ITALIAN SHIPPING LOSSES.—The total of German shipping losses sustained up to Sunday, August 4th, is stated to amount to approximately 918,000 tons, and Italian losses to 254,000 tons, making a total of approximately 1,172,000 tons, while in addition about 26,000 tons of shipping formerly neutral, but now under enemy control, has been sunk.

MERCANTILE LOSSES DUE TO ENEMY ACTION.—Mercantile losses due to enemy action for the week ended Sunday, July 28th, included eighteen British ships totalling 65,601 tons and two Allied ships totalling 7090 tons. No neutral vessels were sunk during the week, so that the total is twenty ships aggregating 72,691 tons. It is worthy of note that the German Government claims to have sunk 229,298 tons of merchant shipping during this period, a statement which requires no comment.

R.A.F. WIRELESS OPERATORS.—Recruits are needed by the Royal Air Force to be trained as wireless operators. The pay will be 2s. a day on enlistment, increasing to 3s. 6d. a day when qualified. In addition, they will be given an opportunity to volunteer for additional training as air gunners and qualifying for an air crew. In this case, upon qualification as a wireless operator air gunner, the pay will be 7s. 9d. a day, with the rank of sergeant. The qualifications for enlistment as wireless operators under training are:—Age, between eighteen and thirty-eight; medical category, 1, 2A, 2, or 3; a good standard of education and quick intelligence.

A NEW SHIPPING COMPANY.—Mr. P. de Malglaive, well known as managing director in London of the Compagnie Générale Transatlantique, has formed a new company, registered as De Malglaive Shipping, Ltd. The nominal capital of the company is £1000, and the objects are to become shipowners and managers of shipping property, freight contractors, shipbreakers, &c. The directors are Mr. Ernest C. Nightingale and Mr. Henry Daniels. Mr. de Malglaive is the governing director. The registered offices are at 20, Cockspur Street, London, S.W.1, the offices of the French Line. The new company will not be taking over the vessels of the French Line.

LIFE-SAVING RAFT LIGHT.—A new accessory for use with life-saving rafts has been marketed by the International Marine Radio Company, Ltd., under the name "S.O.S. Raft-o-Lite." It consists of a light which is supported by a float, at the upper end of a metallic tube, 2ft. 6in. above sea level, the electric bulb being mounted in an armoured glass housing. Below the float is a metal compartment containing batteries and mechanism for flashing continuously the S.O.S. signal. The device is stated to be absolutely water-tight. The light is arranged automatically to be switched on when in the vertical position; when not in use the buoy is stowed in a horizontal position.

ATLANTIC CIVIL FLIGHTS.—The British Overseas Airways Corporation's flying boat "Clare," an aircraft of the strengthened "Empire" class, arrived at New York *viâ* Montreal on August 4th, after a North Atlantic flight from Eire to Botwood, Newfoundland, of 16 h. 6 min. duration. This flight is the first of a short series which the Corporation is undertaking in continuation of its experimental service last summer. The American "Clipper" service between New York and Lisbon made its two-hundredth flight on August 3rd. Since its inauguration early last year it has carried 2600 passengers, 12,300,000 letters and flown an aggregate distance of 750,000 miles.

Miscellanea

ADMIRALTY LABOUR ADVISER.—Mr. William Westwood, O.B.E., J.P., has been appointed Principal Labour Adviser to the Board of Admiralty.

THE CENTRAL REGISTER.—The Minister of Labour and National Service has appointed Mr. O. V. Guy, D.S.O., M.C., Secretary of the Cambridge University Appointments Board, to the post of Assistant Secretary in charge of the Central Register, in place of Miss B. M. Power, who has been lent to the Children's Overseas Resettlement Board.

DIRECTOR OF MACHINERY LICENSING.—The President of the Board of Trade has appointed Mr. R. Hugh Roberts to be Director of Machinery Licensing. Mr. Roberts, who was formerly Deputy Director-General of Equipment and Stores, Ministry of Supply, will be responsible for the licensing of machinery and plant under the Machinery and Plant (Control) (No. 2) Order, 1940, issued on August 1st.

MACHINERY AND PLANT ORDER.—By the Machinery and Plant (Control) (No. 2) Order, 1940, issued on August 1st, additions are made to the list of machinery plant or parts which may not be acquired from or disposed of by United Kingdom manufacturers except under licence by the Board of Trade. Driving plant is now included in the list, which has been extended from sixteen to forty items. All persons who propose to acquire machinery, plant or parts in the specified classes—excepting woodworking machinery and plant required for the conversion of home-grown timber—from a United Kingdom manufacturer must first obtain a supply licence from the Industrial Supplies Department (Machinery Licences Division), Board of Trade, 25, Southampton Buildings, London, W.C.2, and no manufacturer may dispose of or agree to dispose of machinery or plant or parts without first ascertaining that the person to be supplied has already obtained a licence for the supply from him of that machinery or plant or parts.

LARGE BLAST-FURNACE.—The trend in the size and capacity of American blast-furnaces is upward. In America some time ago a furnace with a productive capacity of 1000 net tons of pig iron a day was thought to be very large, but we learn of a new furnace with a capacity of 1350 tons a day. It has been built for the Republic Steel Corporation, at its Warren, Ohio, works, and is said to be the largest blast-furnace in the world.

METAL MINING IN CALIFORNIA.—The total value of gold, silver, copper, lead, and zinc recovered from ores, old tailings and gravels in California in 1939 was 52,918,012 dollars. This figure was greater than that for any year since 1856, and exceeded the 1938 total value by over five million dollars, or 11 per cent., according to final figures compiled by the San Francisco office of the Bureau of Mines, United States Department of the Interior. Although gold accounted for most of the increase, the output of each of the other four metals was larger in both quantity and value in 1939 than in 1938.

ALUMINIUM DUST AND SILICOSIS.—An article in *Engineering News-Record* states that as a means of preventing silicosis amongst mining and tunnelling workers a Canadian mine regularly makes use of aluminium dust dispersed by the face blast. A small amount of powder placed at the face of the workings after loading a round is dispersed by the shot. Extensive laboratory and clinical study have shown that the dangerous fine silica particles are blanketed if the aluminium amounts to 1 per cent. of the rock dust, and if it is sufficiently fine and grease-free. Treatment of silicotic cases with aluminium dust has also shown promising results.

REWARDS FOR ARMAMENT WORKERS' IDEAS.—The Ministry of Supply states that more of Britain's arms workers are to be encouraged to put forward their ideas for helping the national war effort. Schemes have been in force in the Royal Ordnance factories by which workpeople have submitted their suggestions, some of which have been adopted. Many cash awards have been made. Several hundred other factories engaged on war contracts for the Ministry are now being approached by the Minister of Supply, who suggests that awards may be made for proposals leading to economy, increased production, new designs of tools or machines, improved methods, saving of waste material, use of cheaper kinds of material, and prevention of accidents.

BEILBY MEMORIAL AWARDS.—From the interest derived from the invested capital of the Sir George Beilby Memorial Fund, at intervals to be determined by the administrators representing the Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, awards are made to British investigators in science to mark appreciation of records of distinguished work. Preference is given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy, and awards are made, not on the result of any competition, but in recognition of continuous work of exceptional merit, bearing evidence of distinct advancement in science and practice. In general, awards are not applicable to workers of established repute, but are granted as an encouragement to younger men who have done original independent work of exceptional merit over a period of years. The administrators of the Fund—the Presidents, Honorary Treasurers and Secretaries of the three participating institutions—will be glad to have their attention drawn to outstanding work of the nature indicated, not later than November 1st, 1940. All communications on this subject should be addressed to the Convener, Sir George Beilby Memorial Fund, Institute of Chemistry, 30, Russell Square, London, W.C.1.

PERSONAL AND BUSINESS ANNOUNCEMENTS

MESSRS. C. S. MEIK AND HALCROW, and Mr. W. T. Halcrow, M. Inst. C.E., have changed their address to Alliance House, Caxton Street, Westminster, S.W.1.

WILD-BARFIELD ELECTRIC FURNACES, Ltd., informs us that from August 12th its address will be Elecfurn Works, Watford By-Pass, Watford, Herts. Telephone, Watford 6094; and telegraphic address, "Elecfurn, Watford."

MR. EDWARD BAYNES has been appointed Secretary of the Association of Consulting Engineers (Incorporated). Mr. Baynes was formerly Administrator of St. Lucia, West Indies, and retired from the colonial service two years ago.

JOHN I. THORNYCROFT AND CO., Ltd., announce that on account of the necessity for concentrating on the extensive production of engines and other war material at the company's marine engine works, special arrangements have been made for the overhaul and repair of marine engines at a fully equipped and up-to-date repair shop established on the South Coast. Further information concerning the despatch of engines requiring overhaul or repair will be furnished on application to Thornycroft House, Smith Square, London, S.W.1.

CATALOGUES

HEENAN AND FROUDE, Ltd., Worcester.—Folder No. 116/1 on the T-type cooler.

TANGYES, Ltd., Cornwall Works, Birmingham.—Booklet No. 581 on factory heating stoves.

R. AND J. DICK, Ltd., Greenhead Works, Glasgow, S.E.—Booklet giving general particulars of "Dickropes."

GRIFFIN AND TATLOCK, Ltd., Kemble Street, Kingsway, W.C.2.—Catalogue No. 65CR of laboratory chemicals.

WHESSOE FOUNDRY AND ENGINEERING COMPANY, Ltd., Darlington.—Brochure entitled "Blast Furnace Cleaning."

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Booklet N.S. Cds. 1 on the B.I. system of automatic power factor control.

LINCOLN ELECTRIC COMPANY, Ltd., Welwyn Garden City, Herts.—Booklet "101, Welding Ideas for Low-cost Maintenance."